

Systematic Review

Work-Related Thumb Pain is a Common Occupational Hazard in Physiotherapists: A Systematic Review and Meta-analysis

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Abstract

Questions: Is prevalence of Work-Related Thumb Pain (WRTP) high in Physiotherapists (PTs)? Can any risk factors be identified?

Design: Systematic review with meta-analysis of observational studies.

Participants: Practising registered physiotherapists using manual techniques at work without history of injuries or diseases affecting the thumb.

Intervention: Prevalence of WRTP in PTs and risk factors associated to WRTP.

Outcome measures: Current and lifetime prevalence of WRTP in physiotherapists and risk factors associated with WRTP such as preferred manipulation techniques, occupational factors and demographic factors.

Results: Fourteen studies were identified and included in the analysis of the prevalence of WRTP and risk factors associated with WRTP. The lifetime prevalence, one year prevalence and current prevalence were 57.1%(95% CI=47.4%-66.2%), 38.0%(95% CI=28.7%-48.2%) and 42.4%(95% CI=27.8%-58.5%) respectively. In qualitative evidence synthesis, there was strong qualitative evidence showing that using soft tissue mobilization, working hours on manipulation, workplace experience, age and gender were not risk factors associated with WRTP while qualitative evidence for associations with using general mobilization and joint mobilization, workplace setting, and handedness was conflicting. As there are no studies reporting the association between risk factor of thumb overuse and WRTP, limited evidence is found.

Conclusion: WRTP is a common occupational hazard in PTs. Further studies are warranted to investigate the causes and risk factors of WRTP.

Keywords: Prevalence; Physiotherapist; Risk factors; Work-related thumb pain

Introduction

High Risk of Work-Related Thumb Pain in Physiotherapists

Physiotherapists (PTs) are usually required to perform a number of manual techniques when providing treatments to patients with musculoskeletal problems and these techniques are performed by using their thumbs. There will then be a longitudinal force transmitted through their thumbs to mobilize

tissues and manipulate joints of the patients. The anatomical structure of a thumb is weak in with standing biomechanical load and repetitive compression. Therefore, PTs are considered to be under a high risk of Work-Related Thumb Pain (WRTP) [1,2].

Research Gap in the Review of WRTP in PTs

WRTP is a kind of Work-Related Musculoskeletal Disorders (WRMD) that is aggravated or induced by occupational risk factors [3]. There are different studies continuously reporting the prevalence rate of WRTP in PTs these years [4-6]. Nevertheless, there are no systematic reviews and/or meta-analyses providing a summary specifically on the prevalence rate of WRTP. While there are other studies investigating a wide variation of work-related factors associated with WRTP, the quality and result of such studies varied, and no dominant factors could be identified. On the whole, the overall influence of WRTP in PTs remains unclear and further review is necessary.

Occupational Safety and Health of PTs

In clinical practice, WRTP may cause PTs to alter the way they perform manual techniques [7]. This could result in reduced efficiency and effectiveness of manual therapy. Besides, WRTP could be a factor leading practising PTs to leave their working position [8]. Consequently, WRTP negatively affects the welfare of patients and increases costs of social health. To address the problems associated with WRTP, this review provides a more comprehensive investigation on the characteristics of its prevalence and various risk factors associated with WRTP.

The results of this review would contribute to the development of prevention strategies on WRTP and would be beneficial to the occupational safety and health of PTs in the long run. This review aims to systemically appraise published studies which primarily focus on the prevalence and risk factors of WRTP in PTs.

Therefore, the research questions for this study were:

1. Is prevalence of WRTP high in PTs?
2. Can any risk factors be identified?

Method

Identification and Selection of Studies

Search strategy: An extensive literature search was conducted in March 2021 on electronic databases Pubmed, Europepmc, NCBI-NIH and Research Gate by using keywords: “physiotherapist” or “physical therapist” or “manual physiotherapist” AND “work-related thumb disorder” or “work-related thumb pain” or “thumb pain” or “thumb disorder” OR “prevalence” or “trend” OR “risk factors” or factors”. There was no restriction on publication years and types of study in the search. In addition, a manual search on the reference list of the selected studies was also carried out to access potential literature for the review.

Selection criteria: The studies meeting the inclusion criteria were selected for this review. Studies were included if they (1) were observational studies published in English and (2) provided data investigating the prevalence and/or risk factors of WRTP among practising PTs who had no history of injuries and/or diseases affecting their thumbs.

Data which included other types of WRMD and/or data retrieved from PTs applying manipulation and/or grade five mobilization which involved high velocity sudden thrust were excluded (Table 1).

Table 1: Inclusion and exclusion criteria of the literature search.

Inclusion criteria	
•	Observational studies published in English
•	Provision of data investigating the prevalence and/or risk factors of WRTP among practicing PTs who should be without history of injuries and/or diseases affecting the thumb.
Exclusion criteria	
•	Provision of data included other types of WRMD
•	Data retrieved from PTs applying manipulation and/or grade five mobilization which involved high velocity sudden thrust

Table 2: Assessment of the strength of evidence of selected studies on risk factors associated with WRTP.

Strength of Evidence	Evidence Assessment Criteria
Strong evidence	Consistent findings in two or more high-quality studies
Moderate evidence	<ul style="list-style-type: none"> • Consistent findings in one high and one fair-quality study OR • Consistent findings in multiple fair-quality studies OR • Consistent findings in one fair and multiple low-quality studies
Low evidence	Consistent findings in one fair and one low-quality studies
Limited evidence	Only one study is available
Conflicting evidence	Inconsistent findings in the selected studies
No evidence	No studies found

Consistent findings: more than 75% paper reporting the same conclusion.

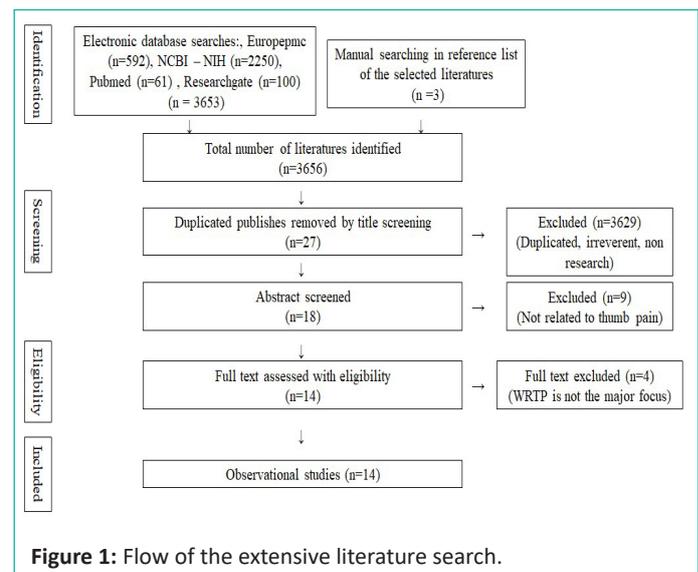


Figure 1: Flow of the extensive literature search.

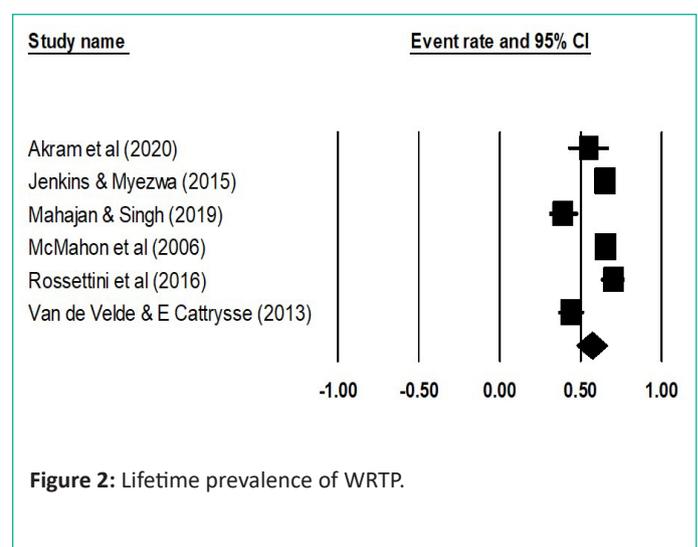


Figure 2: Lifetime prevalence of WRTP.

Table 3: Characteristics of the included studies.

Author/ Year of publication	Study design	Sample size	Part- icipant condition	Country	Workplace setting	Measure- ment tool	Study focus	Main finding of primary outcome measures		Secondary outcome measures
								Significant risk factors associated with WRTP	Prevalence of WRTP	
1. [14]	CSS	n =966	PT with thumb pain	Australia	All settings in Australia	Q	P/R	Factors of general mobilization technique and handeness are associated with WRTP while the factors of soft tissue mobiliza- tion technique, working hours, workplace ex- perience, age, and gender do not.	Lifetime preva- lence (55%) Current preva- lence (42%)	Preferred treatment of WRTP
2. [8]	CSS	n=824	PT with thumb pain	Australia	All setting in Australia	Q	P/R	Factors of working hours, workplace setting, age, and gender are associated with WRTP while the factors of general mobilization technique, and joint mobiliza- tion technique do not.	One-year prevalence (34%)	Nil
3. [15]	CSS	n=350	PT with thumb pain	South Africa	All settings in South Africa	Q	P/R	Factors of gen- eral mobiliza- tion technique, soft tissue mobilization technique, joint mobilization technique, overuse of thumb are associated with WRTP while the factors of workplace set- tings and age do not	Lifetime preva- lence (65%)	Nil
4. [18]	CSS	n=118	PT with thumb pain	India	Clinical and hospital setting	Q	P	Nil	Lifetime preva- lence (39%)	Level of pain intensity of WRTP Consequences of WRTP

5. [4]	CSS	n=1102	PT with thumb pain	Australia	All settings in Australia	Q	P/R	Factors of general mobilization technique, soft tissue mobilization technique, joint mobilization technique, workplace setting, and gender are associated with WRTP while factors of working hours workplace experience, handeness, age do not.	Lifetime prevalence (65%) Current prevalence (41%)	Consequences of WRTP Preferred treatment of WRTP
6. [19]	CSS	n=216	PT with thumb pain	Pakistan	Private and Government sector	Q	P	Nil	Current prevalence (69%)	Level of pain intensity of WRTP Consequences of WRTP
7. [21]	CCS	n=150	PT with and without thumb pain	United Kingdom	Outpatient setting	Q	R	Factors of general mobilization technique, workplace setting, and workplace experience are associated with WRTP while the factor of age do not.	Nil	Nil
8. [6]	CSS	n=219	PT with thumb pain	Italy	All settings in Italy	Q	P/R	Factors of general mobilization technique, soft tissue mobilization technique, workplace experience and gender are associated with WRTP while the factors of joint mobilization technique, working hours, workplace setting, handeness and age do not.	Lifetime prevalence (70%) One-year prevalence (49%)	Level of pain intensity of WRTP Consequences of WRTP Preferred treatment of WRTP
9.[1]	CCS	n=44	PT with and without thumb pain	Australia	Outpatient setting	Q/E	R	Factors of general mobilization technique, soft tissue mobilization technique, joint mobilization technique, working hours, workplace experience, age gender are not associated with WRTP.	Nil	Nil

10. [16]	CSS	n=107	PT with thumb pain	Zimbabwe	All setting in Zimbabwe	Q	P/R	Factors of age and working hours are associated with WRTP.	One-year prevalence (33%)	Nil
11. [5]	CSS	n=157	PT with thumb pain	Belgium	All setting in Belgium	Q	P/R	Factors of handness, general mobilization technique are associated with WRTP while the factors of soft tissue mobilization technique, working hours, workplace setting, gender, age do not.	Lifetime prevalence (44%) Current prevalence (17%)	Level of pain intensity of WRTP Preferred treatment of WRTP
12. [20]	CSS	n=155	PT with thumb pain	Australia	All setting in Australia	Q	P/R	Factors of general mobilization technique, joint mobilization technique are associated with WRTP while the factors of workplace experience, and handness do not.	Excluded	Nil
13. [22]	CSS	n=129	PT with thumb pain	Australia	All setting in Australia	Q/E	P/R	Factors of general mobilization technique and joint mobilization technique are associated with WRTP.	Excluded	Nil
14. [17]	CSS	n=100	PT with thumb pain	Pakistan	Rehabilitation centers	Q	P/R	Factor of handness is associated with WRTP while the factor general mobilization technique, soft tissue mobilization technique and gender do not.	Current prevalence (48%)	Level of pain intensity of WRTP Consequences of WRTP Preferred treatment of WRTP

CSS: Cross Sectional Survey; CCS: Case Controlled Study; Q: Self-Designated Questionnaire; E: Examination; P: Prevalence of WRTP; R: Risk Factors of WRTP

Table 4: Result of JBI critical appraisal checklist for studies reporting prevalence data.

Item number	1	2	3	4	5	6	7	8	9	Score (0-9)	Score in %	Study quality
1. [20]	✓	×	×	✓	✓	✓	×	✓	✓	6	67%	Fair
2. [8]	✓	✓	✓	✓	✓	✓	×	✓	✓	8	89%	High
3. [15]	✓	0	✓	✓	✓	✓	×	✓	✓	7	78%	Fair
4. [18]	✓	×	×	✓	✓	✓	✓	✓	✓	7	78%	Fair
5. [4]	✓	✓	✓	✓	✓	✓	0	✓	✓	8	89%	High
6. [19]	✓	×	0	✓	✓	✓	✓	0	✓	6	67%	Fair
7. [6]	✓	✓	✓	✓	✓	✓	×	✓	×	6	67%	Fair
8. [16]	✓	✓	✓	✓	✓	✓	×	✓	✓	8	89%	High
9. [5]	✓	×	✓	✓	✓	✓	×	✓	0	6	67%	Fair
10. [20]	✓	×	0	✓	✓	×	×	✓		4	44%	Low
11. [22]	✓	0	0	✓	0	✓	0	✓	0	4	44%	Low
12. [17]	✓	×	0	✓	✓	✓	×	✓	0	5	56%	Fair

Answer to the items: ✓ = Yes; × = No; 0 = Not clear

Selection process: The titles and abstracts of all the identified studies were screened by three reviewers independently according to the predetermined eligible criteria. When a study was found to be potentially eligible, reviewers would review the study in full text. If there was disagreement on eligibility, it was resolved by discussion among the three reviewers until consensus was reached.

Assessment of Characteristics of Studies

Quality appraisal: Two critical appraisal tools from Joanna Briggs Institute (JBI) were adopted for the quality appraisal of the selected studies - JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data for studies investigating prevalence of WRTP (Appendix 1) and JBI Critical Appraisal Checklist for Analytic Cross Sectional Studies for studies investigating risk factors related to WRTP (Appendix 2).

This appraisal aimed to assess the methodological quality of a study and determine the extent to which a study has addressed the possibility of bias in its study design, conduction and data analysis. Three independent reviewers assessed the quality of the selected studies. Any disagreement was resolved by discussion until consensus was reached among the three reviewers.

According to the JBI reviewer manual, a decision over the scoring and cut-off point should be agreed by at least two reviewers before the quality assessment of the selected studies was conducted [9]. Therefore, in the current review, the scoring and cut-off point of the two critical appraisal checklists were pre-determined by the three independent reviewers [10].

The available answers to each item in the two checklists included "Yes", "No" and "Unclear". It was determined that one score would be given to the answer "Yes" while no score would be given to the answers "No" and "Unclear". The maximum score of each checklist should be the same as the number of items in that checklist. The overall score of each selected study would be presented in percentage and the quality would be rated as "low" (0-50%), "fair" (51-80%) or "high" (81%-100%). Selected studies investigating the prevalence of WRTP being rated as low quality would be excluded to secure the validity of the included data used for meta-analysis [11].

Data Analysis

Data extraction: Data extraction was carried out by the three reviewers and cross-check was done. Disagreement was resolved by discussion among the reviewers until consensus was reached.

Data for analysis were extracted from the selected studies to two pre-designed tables which included study characteristics (author, year of publication, study design, country, participant condition, sample size, workplace setting, measurement tool used and study focus) and statistical data (prevalence rate, risk factors, level of pain intensity, consequence and treatment of WRTP).

Data Synthesis

Data of prevalence and risk factors of WRTP were synthesized separately according to the following methods.

Prevalence of WRTP: Selected studies investigating the prevalence of WRTP with quality rated as "fair" and "high" were included for meta-analytical prevalence. Other analyzable data

including level of pain intensity, consequence and treatment of WRTP were also investigated as the secondary outcome measures.

The meta-analysis was calculated by using the software "Comprehensive meta-analysis". Data of prevalence of WRTP were first categorized into three subgroups, namely "lifetime prevalence", "one-year prevalence" and "current prevalence", which meant the participants had at least experienced one time of thumb pain in a lifetime, the past one year, and at the current time respectively.

Data of the same subgroup were then pooled to calculate the weighted prevalence rate across studies with 95% CI presented. The data for the secondary outcomes were also weighted. Heterogeneity among studies was determined by the Cochran's Q test and I^2 index. If there was heterogeneity, the random-effect model was adopted. The significant level was set at $p < 0.05$.

Risk factors associated with WRTP: The number of studies evaluating risk factors associated with WRTP was counted. The strength of evidence of the selected studies reporting significant and non-significant associations between WRTP and different risk factors were assessed respectively. The strength of evidence was pre-determined according to the evidence assessment criteria as set out in Table 2 [12,13].

If the strength of evidence of the selected studies reporting significant associations between WRTP and one risk factor was stronger than those reporting non-significant associations, the presence of association between WRTP and that factor could be concluded and vice versa.

If inconsistent findings were found in the selected studies, it would be concluded as conflicting evidence. If there were no studies available, it would be concluded as no evidence identified.

Results

Flow of Studies through the Review

Initially a total of 3,653 studies through electronic databases and 3 articles from manual search on the reference list were identified. Among the 3,656 articles, 3629 studies were removed due to duplication or irrelevance. Nine articles were further excluded after abstract screening as they did not investigate WRTP in practicing PTs. At the stage of full text screening, 4 more studies were excluded as either WRTP was not the major focus of the study, or the inclusion criteria were not met. As a result, 14 observational studies were included in this review. The flow of the extensive literature search was shown in (Figure 1).

Characteristics of the Studies

Summary of the selected studies: Among the 14 selected studies, 12 of them were cross sectional studies while 2 were case control studies. Overall, data from a total of 4,632 PTs working in different settings including "all setting in a country", "rehabilitation center", "outpatient setting", "private and government sector" and "clinical and hospital setting" were analyzed. These studies were conducted in different countries including Australia, South Africa, India, Pakistan, the United Kingdom, Italy, Zimbabwe and Belgium.

Questionnaire was adopted as the measurement tool in all 14 selected studies while 2 of them also adopted examination.

In terms of the study focus, 10 studies focused on investigating both prevalence and risk factors of WRTP. Two studies only focused on investigating the prevalence of WRTP and 2 studies only focused on investigating the risk factors of WRTP. Study characteristics of the 14 selected studies are shown in (Table 3).

The details of the 14 studies are shown in (Table 3). Among the 14 studies, there were 10 studies reporting the prevalence of WRTP in terms of lifetime prevalence, one year prevalence and/or current prevalence. Twelve studies reported risk factors associated with WRTP and 7 studies reported other relevant outcomes including the level of pain intensity, consequences and/or preferred treatment of WRTP.

Quality appraisal: Methodological quality assessment of the 12 studies investigating the prevalence of WRTP is shown in (Table 4). Three studies were graded as “high” quality. Seven studies were graded as “fair” quality and 2 studies were graded as “low” in quality appraisal. The 2 studies with low quality were excluded for data synthesis. Details of the methodological appraisal for the 12 studies reporting risk factors of WRTP are shown in (Table 5). Two studies were graded as “high” quality. Six studies were graded as “fair” quality and 4 studies were graded as “low” in quality appraisal.

Effect of Intervention

Weighted prevalence of WRTP: After conducting the quality appraisal of the selected studies, a total of 2,644 PTs from 10 studies [4-6,8,14-19] were included in the analysis of prevalence of WRTP.

A. Lifetime prevalence of WRTP

As shown in Figure 2, the weighted lifetime prevalence was investigated in 6 studies with a sample size of 1,709 PTs [4-6,14,15,18]. The prevalence rate was 57.1% (95% CI=47.4%-66.2%). As heterogeneity existed among the 6 studies ($I^2=91.7%$; $p=0$), random effect model was selected.

B. One-year prevalence of WRTP

The weighted one-year prevalence was investigated in 3 studies with a sample size of 727 PTs [6,8,16]. As shown in (Figure 3), the prevalence rate was 38.0% (95% CI=28.7%-48.2%). As heterogeneity existed among the 3 studies ($I^2=79.2%$; $p=0.022$), random effect model was selected.

C. Current prevalence of WRTP

The weighted current prevalence was investigated in 5 studies with a sample size of 1,494 PTs [4,5,14,17,19]. As shown in (Figure 4), the prevalence rate was 42.4% (95% CI=27.8%-58.5%). As heterogeneity existed among the 5 studies ($I^2=95.7%$; $p=0$), random effect model was selected.

Factors Associated with WRTP

A. Manipulation technique associated with WRTP

General mobilization technique

There were 11 studies reporting the association between general mobilization technique and WRTP [1,4-6,8,14,15,17,20-22]. Eight of them discovered that the general mobilization technique was associated with the WRTP while 3 of them suggested no association. It was concluded that there was conflicting evidence in its correlation with WRTP (Table 6).

Soft issue mobilization technique

There were 7 studies reporting the association between soft tissue mobilization technique and WRTP [1,4-6,14,15,17]. Soft tissue mobilization technique refers to all the techniques performed on soft tissue. Massage and trigger point therapy were major types of soft tissue mobilization technique investigated in the studies. Among the 7 studies, 3 of them found an association between soft tissue mobilization technique and WRTP while 4 of them suggested no association. It was concluded that there was strong evidence showing that soft tissue mobilization technique was not associated with WRTP (Table 7).

Joint mobilization technique

There were 7 studies reporting the association between joint mobilization technique and WRTP [1,4,6,8,15,20,22]. Joint mobilization technique refers to the performance of mobilization techniques on joints which are hard. The joint mobilization techniques investigated in the selected studies mainly included central posterior-anterior pressure, unilateral posterior-anterior pressure, transverse glide, Mulligan glides and Maitland manual techniques. Among the 7 studies, 4 of them found an association between joint mobilization technique with WRTP and while 3 of them suggested no association. It was concluded that there was conflicting evidence in the correlation between joint mobilization technique and WRTP (Table 8).

B. Occupational factors

Working hours on manipulation

There were 7 studies revealing the association between working hours on manipulation and WRTP [1,4-6,8,14,16]. Two of them yielded the same result that long working hours on manipulation was associated with WRTP. However, the remaining 5 studies found no association. To conclude, there was strong evidence illustrating that working hours on manipulation was not associated with WRTP (Table 9).

Workplace setting

There were 6 studies revealing the relation between workplace settings and WRTP [4-6,8,15,21]. Investigated workplace setting included inpatient, outpatient, private and rehabilitation centers and pediatric centers. Among these settings, outpatient setting was reported by 3 of the studies to be most frequently associated with WRTP while another 3 studies suggested no association. To conclude, conflicting evidence in the association between workplace setting and WRTP was shown (Table 10).

Working experience

There were 5 studies revealing the relation between working experience and WRTP [1,4,6,14,20]. One of them reported association between PTs with working experience of 0-5 years and WRTP while another 4 studies suggested no association. It was found that there was strong evidence showing working experience was not associated with WRTP (Table 11).

C. PT's Practising Habit

Overuse of thumb

There was only 1 study revealing the relation between overuse of thumb and WRTP [15]. The study reported that overuse of thumb was associated with WRTP. There was limited evidence showing the association between overuse of thumb and WRTP (Table 12).

Handedness

There were 6 studies revealing the relation between handedness and WRTP [4-6,14,17,20]. Three of them indicated that WRTP was associated with the usage of dominant thumb while the remaining 3 studies suggested no association. It was shown that conflicting evidence was observed in the association between handedness and WRTP (Table 13).

D. Demographic

Age

There were 9 studies revealing the association between age and WRTP [1,4-6,8,14-16,20,21]. One of them reported that PTs in the age group of “25-29” and “30-34” were associated with WRTP. In addition, another study showed that younger PTs generally had higher rate of WRTP. Strong evidence was shown in the association between age and WRTP (Table 14).

Gender

Seven studies revealed the relation between gender and WRTP [1,4-6,8,14,17]. Two of them indicated that male had a significantly higher rate of having WRTP while there was only 1 study showing that female was more prone to having WRTP.

The other 4 studies reported no association between gender and WRTP. Strong evidence was shown in the association between gender and WRTP (Table 15).

Level of pain intensity, consequence and preferred treatment of WRTP

A. Level of pain intensity of WRTP

The level of thumb pain intensity was summarized in (Table 16). Three studies with 225 PTs used the Numerical Rating Scale (NRS) as the measuring tool. Due to the presence of heterogeneity ($I^2=89.6\%$, $p=0$), random effect model was selected. The weighted mean of pain score was 3.70 (CI=3.0–4.4) which indicated mild to moderate pain intensity.

One study with 48 PTs used 10cm Visual Analogue Scale (VAS) as the measuring tool. The mean pain score was 3.66 (SD±2.7) which indicated mild to moderate pain intensity. Another study with 46 PTs used 100mm VAS as the measuring tool. As the pain score was categorized, mode was used to present the score. Out of the 46 PTs, most of them reported 5-44mm of pain score. The rest reported moderate intensity (45-74mm) and no PTs reported severe pain (75-100mm).

B. Consequence of WRTP

The consequence of WRTP was summarized in (Table 17). Except the consequence of “career change”, all the meta-analysis adopted random effect model due to the presence of heterogeneity. No meta-analysis was conducted on the consequence of “impairment of Activity of Daily Living (ADL)” as it was reported by 1 study only. Common consequence of WRTP included changes in choice of treatment technique (25.1%), changes of implementation of treatment techniques (21.1%), reduction of working hours (10%), reduction of number of patients treated (8.2%), impairment of ADL (4.6%) and career change (3.9%).

C. Preferred treatment of WRTP

The preferred treatment of WRTP was summarized in (Table 18). All the meta-analysis adopted random effect model due to the presence of heterogeneity. No meta-analysis was con-

ducted for those treatments only reported by one study. The preferred treatment of WRTP included rest (64.5%), taping (27.4%), electro therapy (20.4%), stabilization exercise (19.9%), splinting (10.5%), medication (6%) and injection (1%).

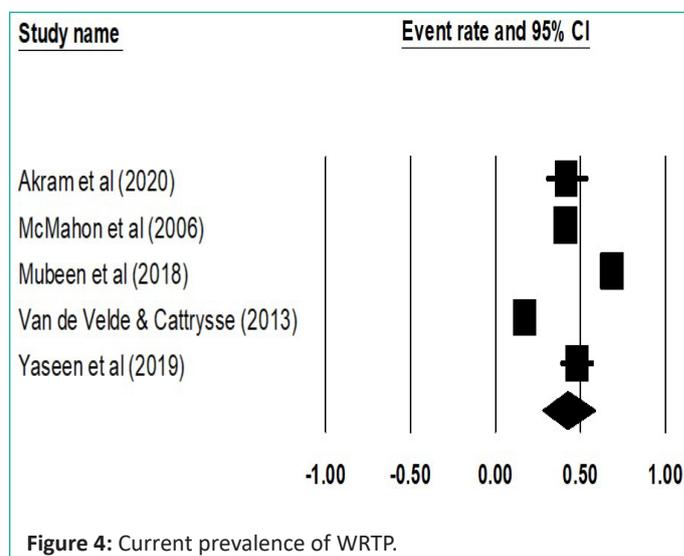
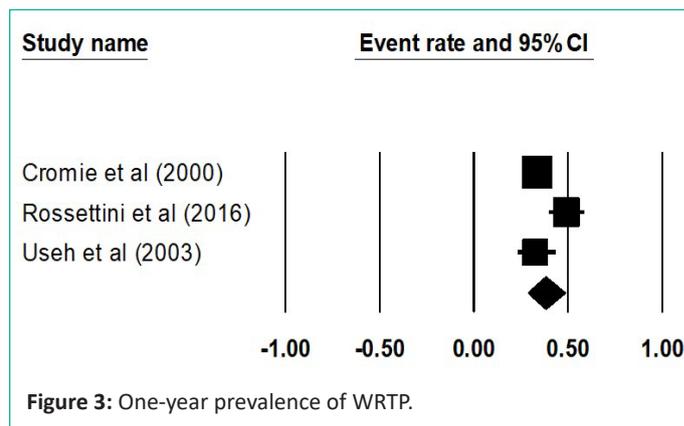


Table 5: Result of JBI Critical Appraisal Checklist for Analytic Cross Sectional Studies.

Item number	1	2	3	4	5	6	7	8	Score (0-8)	Score in %	Study quality
1. [20]	✓	✓	✓	✓	✓	×	✓	✓	7	87.5%	High
2. [8]	✓	✓	✓	✓	×	×	✓	✓	6	75%	Fair
3. [15]	✓	✓	✓	✓	×	×	✓	✓	6	75%	Fair
4. [4]	✓	✓	✓	0	✓	×	×	✓	5	62.5%	Fair
5. [21]	0	✓	×	×	✓	✓	×	✓	4	50%	Low
6. [6]	✓	✓	✓	✓	✓	✓	×	✓	5	62.5%	Fair
7. [1]	✓	✓	✓	✓	✓	✓	✓	✓	8	100%	High
8. [16]	✓	✓	✓	✓	✓	×	×	✓	5	62.5	Fair
9. [5]	✓	✓	✓	✓	✓	×	×	✓	4	50%	Low
10.[20]	✓	✓	×	×	✓	×	×	✓	4	50%	Low
11.[22]	✓	✓	0	0	✓	×	×	✓	5	62.5%	Fair
12.[17]	✓	✓	0	0	✓	×	×	✓	4	50%	Low

Answer to the items: ✓ = Yes; ×= No; 0 = Not clear

Table 6: Evidence strength of general mobilization technique as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	8 [4-6,14,15,20-22]	1 high, 3 fair, 4 low	Moderate
Not significantly associated with WRTP	3 [1,8,17]	1 high, 1 fair, 1 low	Moderate

Table 7: Evidence strength of soft issue mobilization technique as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	3 [4,6,15]	All fair	Moderate
Not significantly associated with WRTP	4 [1,5,14,17]	2 high, 2 low	Strong

Table 8: Evidence strength of joint mobilization technique as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	4 [4,15,20,22]	3 fair, 1 low	Moderate
Not significantly associated with WRTP	3 [1,6,8]	2 fair, 1 high	Moderate

Table 9: Evidence strength of working hours on manipulation as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	3 [8,16]	1 fair, 1 low	Low
Not significantly associated with WRTP	5 [1-4,6,14]	2 high, 2 fair, 1 low	Strong

Table 10: Evidence strength of workplace setting as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	4 [4,8,21]	2 fair, 1 low	Moderate
Not significantly associated with WRTP	3 [5,6,15]	2 fair, 1 low	Moderate

Table 11: Evidence strength of workplace experience as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	2 [6]	1 fair	Low
Not significantly associated with WRTP	4 [1,4,14,20]	2 high, 1 fair, 1 low	Strong

Table 12: Evidence strength of overuse of thumb as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	1 [15]	1 Fair	Limited
Not significantly associated with WRTP	0	Not applicable	Not applicable

Table 13: Evidence strength of handedness as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	3 [5,14,17]	1 high, 2 low	Moderate
Not significantly associated with WRTP	3 [4,6,20]	2 fair, 1 weak	Moderate

Table 14: Evidence strength of age as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	2 [8,16]	2 fair	Moderate
Not significantly associated with WRTP	7[1,4-6,14,15,20,21]	2 high, 3 fair, 3 low	Strong

Table 15: Evidence strength of gender as a factor of WRTP.

	No. of reported studies	Study qualities	Evidence grading
Significantly associated with WRTP	3 [4,6,8]	2 fair	Moderate
Not significantly associated with WRTP	4 [1,5,14,17]	2 high and 2 low	Strong

Table 16: Level of pain intensity of WRTP.

Measuring tool	No. of study	No. of participants	Score	Level of pain intensity
NRS	35,6,17	225	Weighted mean (95%CI): 3.70(CI=3.-4.4)	Mild to moderate
10cm VAS	119	148	Mean (SD): 3.7(SD±2.7)	Mild to moderate
100mm VAS	118	46	Mode (n%): 5-44mm (n=27, 58.7%)	Mild

NRS: Numerical Rating Scale; VAS: Visual Analogue Scale; SD: Standard Deviation.

Table 17: Consequence of WRTP.

Consequence	No. of study	No. of participants	Heterogeneity (p; I ²)	Weighted event rate (CI)
Changing in choice of treatment technique	3 [17-19]	65	p=0; I ² =90.5	25.1% (10.7%-48.5%)
Changing of implementation of treatment techniques	2 [17,18]	146	p=0.007; I ² =86.4	21.1% (7.8%-45.8%)
Reducing in working hours	4 [6,17-19]	354	p=0.01; I ² =72.4	10% (5.2%-18.2%)
Reduce number of patients treated	2 [17,18]	146	p=0.03; I ² =79.9	8.2% (2.1%-27.2%)
Impairment of ADL	1 [6]	108	Not applicable	4.60%
Career change	3 [4,6,17]	828	p=0.3; I ² =3.8	3.9% (2.8%-5.5%)

ADL: Activity of Daily Living

Table 18: Preferred treatment of WRTP.

Management strategy	No. of study	No. of participants	Heterogeneity (p; I ²)	Weighted preference (CI)
Rest	3 [5,14,17]	172	p = 0; I ² =77.6	64.5% (46.8%-78.9%)
Taping	5 [4-6,14,17]	908	p = 0.03; I ² =62.1	27.4 % (21.4%-34.3%)
Electro therapy	1 [6]	108	N/A	20.4%
Stabilization exercise	4 [4,5,14,17]	800	p = 0; I ² =85.3	19.9% (11.3%-32.5%)
Splinting	5 [4-6,14,17]	908	p = 0.04; I ² =60	10.5% (6.8%-16%)
Medication	4 [5,6,14,17]	280	p =0.4; I ² =63.9	6% (2.4%-15.6%)
Injection	1 [6]	108	Not applicable	1%

Table 19: Comparison of prevalence rate of work-related hand injury and WRTP in PT.

	Prevalence of work-related hand injury [27]	Prevalence of WRTP in this review
Lifetime prevalence	15-46%	57.1% (95%CI=47.4%-66.2%).
One-year prevalence	5-30%	38.0% (95%CI=28.7%-48.2%)

Discussion

Prevalence of WRTP

Previous studies consistently found that hands including thumbs were the second commonest site of occupational injuries among PTs [23-26]. A literature review summarized the prevalence rate of work-related hand injuries among PTs [27]. As shown in Table 19, lifetime and one-year prevalence rates of acquiring WRTP were higher compared to those of acquiring work-related hand injuries. It is believed that the reason why thumb pain has a higher prevalence rate than hand injuries could be due to the anatomical structure of a thumb. During manipulation, especially in relation to spinal work, PTs usually use their thumbs, instead of the other anatomical structure or tools, to apply longitudinal force to the patients to ensure their sensation needed in manipulation. However, the carp metacarpal joint surface in the thumb is fragile to the force in the longitudinal plane, thus resulting in thumb pain [2].

Implication of Investigating Risk Factors Associated With WRTP

This review also assessed the risk factors associated with WRTP among PTs. Based on the number and quality appraisal of the selected studies, the evidence strength of each risk factor was graded. This provided a conclusion of the accumulated evidence of WRTP which would be useful for treating and preventing WRTP.

Factors of Manipulation

A high prevalence rate of work-related finger injury was also reported in other professions, for example chiropractors [28,29]. Both PTs and chiropractors have high usage of manipulation techniques by the thumb in the provision of daily treatment to their clients. However, in the investigation of the

risk factors of using general and joint mobilization techniques, though there were 8 studies (Tables 6 and 8) revealing a correlation between general and joint mobilization technique and WRTP, the number of high-quality studies was insufficient and conclusion of “contrast evidence” was drawn. Therefore, it is recommended that further studies with high quality are needed to fully reflect the correlation between general and joint manipulation techniques and WRTP.

For soft tissue mobilization, there is strong evidence showing that it was not correlated to the WRTP. Previous studies suggested that there could be 3 major factors leading to WRMD which included force applied through the thumb, posture of PTs and repetitive movement of the thumb [30]. The difference between WRTP relating to soft tissue mobilization and joint mobilization techniques is possibly due to the difference of force applied through the thumb. Less force is required in soft tissue mobilization when compared with joint mobilization technique. Another speculation is that the application of soft tissue mobilization can be applied via various types of instruments where joint mobilization is mostly applied by thumb.

Factors of Practicing Habit

There is strong evidence demonstrating that working hours on manipulation of PTs was not correlated to WRTP. This indicates that the duration of working time might not be a risk factor for WRTP. Other than working hours, the risk factor “overuse of thumb” was investigated. A study revealed that if PTs provided treatment to patients by repeated movement but without having enough rest, they would have a higher risk of acquiring WRMD [31]. Therefore, overuse of thumb could be to a risk factor of WRTP. However, there was only 1 study which specifically investigated this factor, resulting in “limited evidence” shown. It is hence recommended that further studies may be required to investigate relationship between the time and pattern of taking rest during work and WRTP.

Handiness was another risk actor showing contrasting evidence in its correlation with WRTP. Similar studies specifically investigating the risk factor of handedness also raised contrastive findings. A study suggested that a roughly equivalent proportion of prevalence of common hand injuries was observed on both dominant and non-dominant hands while another study suggested that a higher prevalence rate of upper extremity musculoskeletal disorders was observed on dominant hand on females [32,33]. Therefore, it is expected that future studies in this area will be prone to showing contrastive evidence.

Age and Years of Working Experience

Some studies hypothesized that, compared to some senior PTs, the manipulation skill of the younger and inexperienced PTs could be immature and they might be prone to overuse of their thumbs due to their reluctance to seek assistance [6,8]. However, from the findings in this review, strong evidence was shown that age and working experience were not correlated with WRTP. Therefore, the skill maturity and attitude of young PTs could not be a critical reason determining WRTP.

Workplace Setting

Contrastive evidence has been shown in investigating the risk factor of workplace setting. A previous study investigated that different workplace settings had different scopes of work and environment. As a result, the prevalence rate of work-related hand injury in PTs varied across different settings [34].

This is similar to the result of contrastive evidence shown in this review. However, it was demonstrated that outpatient setting was a setting most frequently associated with WRTP [4,21,35]. Therefore, it is recommended that further studies should investigate the characteristics of outpatient clinics and examine what characteristics in this setting are associated with WRTP.

Pain and Consequence of WRTP

Three different measurement tools (NRS, 10cm VAS and 10mm VAS) were used to measure the level of pain intensity in PTs with WRTP in the selected studies. Results from 3 measuring tools were consistent in that most PTs were suffering from thumb pain in mild to moderate intensity and a few PTs were suffering from high-intensity thumb pain. A study found that pain intensity was associated with the consequences of WRTP. PTs with a significantly high pain intensity tended to report the consequence of "impairment in ADL" and "reduction of their working hours" while PTs with a mild to moderate pain intensity did not [6].

Treatment and Prevention of WRTP

In view of the preferred treatment of PTs with WRTP, they preferred resting and physiotherapy to medical treatment. Also, treating PTs may provide joint stabilization technique to their patients including splinting, taping or stabilization exercise. Nevertheless, the effectiveness and side effect of the preferred treatment were not confirmed. The most welcome treatment did not imply high treatment efficiency. Therefore, it is recommended to conduct further studies on it.

In view of the prevalence rate, WRTP is an occupational hazard to PTs. However, some studies demonstrated that the primary prevention of WRTP was not emphasized in the workplace. A study reported that 91% of PTs with WRTP had never received the preventive advice on WRTP. In another study, 52% of PTs with WRTP did not receive any preventive information related to WRTP [5,14]. Therefore, the promotion of WRTP to raise PTs' awareness of the problem is advised.

Limitations

This study included mainly cross-sectional studies where a causal relationship could not be drawn between risk factors and WRTP. As there was no standard tool to evaluate the risk factors, different studies developed their own questionnaires resulting in a wide scope of risk factors being investigated. Therefore, this review failed to specifically review and compare every single risk factor in detail. Nevertheless, different risk factors were categorized for the qualitative synthesis.

In addition, the questionnaires were self-reported by the PTs. Recall bias could occur and the risk factors or symptoms might be over-reported. From the result of the quality appraisal, measurement bias and confounding bias lowered the quality of most of the studies. This might eventually affect the validity of this review. In the meta-analysis, as some analytical data were only provided by a few or just one study with a limited sample size involved, this might affect the result validity.

Conclusion

In this study, the prevalence of WRTP was analyzed. The lifetime prevalence was 57.1%(95% CI=47.4%-66.2%). One year prevalence was 38.0%(95% CI=28.7%-48.2%) and current prevalence was 42.4%(95% CI=27.8%-58.5%). The evidence strength of different risk factors was also concluded in this review. Con-

trastive evidence was noted in risk factors of general mobilization technique, joint mobilization technique, workplace setting and handedness. Strong evidence was demonstrated that soft tissue mobilization, working hours on manipulation, workplace experience, age and gender were not associated with WRTP. Limited evidence was concluded in the risk factor of overuse of thumb associated with WRTP.

Results of this review also showed that PTs generally suffered from a mild to moderate intensity of WRTP. Common consequences of WRTP included changes in choice of treatment technique, changes of implementation of treatment techniques, reduction in working hours, reduction of number of patients treated, impairment of ADL and career change. To deal with the pain syndrome, PTs generally chose the treatment of taping, electro therapy, stabilization exercise, splinting, medication, and injection. PTs commonly preferred physiotherapy and rest to medical treatment.

WRTP continues to be a prevalent problem among PTs and one of the occupational health issues which is worth of wide concern. Results of this current study should be considered in the design of further studies to address the causes and risk factors of WRTP.

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