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Chronic Whiplash Syndrome: Associated Disorders and Physiotherapy Management – A Literature Review

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ABSTRACT

Purpose: **The purpose of the current literature review is to present the Whiplash Associated-Disorders through diagnosis, scales, physical examination and to identify the most suitable physiotherapy management of these conditions. The long-term effectiveness of physiotherapy interventions is also examined.** ***Methods:*** **Sixteen randomized controlled trials (RCTs) and seven case-control and cohort studies related to chronic WAD fulfilled the inclusion and exclusion criteria. The design, diagnosis, population, methodology, results, methodological quality and physiotherapy management were examined. The PEDro Scale and the Newcastle-Ottawa Scale were used for the examination of the methodological quality.** ***Results:*** **The methodological quality of the studies used, were high. Significantly important on minimizing the symptoms of chronic WAD were the combination of Exercise therapy & Advice both at 6 and 12 months follow up. Other interventions such as Exercise therapy, Interdisciplinary approach and Multimodal physiotherapy**

treatment, Spinal Manual therapy and Advice were not equally effective in the long-term. *Conclusion:* The most suitable intervention for the physiotherapy management of chronic WAD, with long-term effectiveness was the combination of Exercise & Advice, which was established with various outcome measures, such as NDI, VAS, NRI and SF-36. On the contrary, Exercise therapy, Interdisciplinary approach and Multimodal physiotherapy treatment, Spinal Manual therapy and Advice were not that effective on minimizing the symptoms of chronic WAD in the long-term.

INTRODUCTION

Whiplash-associated disorders (WAD) clinical description and economic impact

Whiplash appears to be one of the most painful, controversial and debated musculoskeletal conditions worldwide (Pato et al 2010; Sterling 2011). Whiplash was first defined in 1995 by Spitzer et al. as "an acceleration-deceleration mechanism of energy transfer to the neck, usually occurring during a motor vehicle collision". Hence, Stovner in 1996 termed as "Whiplash-Associated Disorders (WADs)" the clinical manifestation of the whiplash injuries (Stovner 1996 cited in Dufton et al. 2012). The impacts of a motor collision injury are plenty. After the injury, there can be a range in the severity of clinical symptoms and physical findings. WAD can be categorized as grades 0-IV, where a higher grade indicates increased severity (Rushton et al. 2011; Corkery et al 2014).

According to Haggman-Herniknon et al. (2013), most individuals almost fully recover from acute whiplash injury within the first three months after the injury, although a substantial number of them will develop chronic symptoms. Specifically, up to 50% of people present with continuous neck pain and disability one year after the injury (Carroll et al. 2008; Sterling 2014), whereas 40-60% of those injured have chronic symptoms (Soderlund & Lindberg 2007; Rushton et al. 2011). Chronic Whiplash Syndrome or Chronic WAD is a condition of over six months of duration (De Kooning et al. 2013). The main symptoms of chronic WAD are chronic neck pain, dizziness, neck stiffness, unsteadiness, headaches, fatigue, upper limb paraesthesia, concentration difficulties, psychological factors and emotional sequelae (Scholten-Peeters 2002; Treleaven et al 2003; Poorbaugh et al. 2008; Schmitt et al. 2009; Treleaven 2011; De Kooning et al. 2013).

WAD is a significant public health problem with essential social and economic burdens (Jull et al. 2011; Ludvigsson et al. 2015(1)). Recent figures suggesting more than 300 persons per 100.000 were reported in emergency departments every year in Europe and North America suffering from whiplash injuries, while in Australia almost 75% of all survivable road traffic crash injuries suffer from whiplash injuries (Sterling 2014). Annually, the incidence in Quebec, Canada is about 70 per 100.000 inhabitants, in Netherlands 67-133 per 100.000 inhabitants (Schmitt et al. 2009) and in Sweden 1-2 per 1.000 inhabitants (Haggman- Henriknon et al. 2013). The economic costs of WAD including medical care, disability, lost work productivity and personal costs are substantial (Sterling 2011). The cost of management of the condition and time spent off work was estimated as $3.9 billion in the USA and €10 billion in Europe (Rushton et al. 2011), while in Australia between 2011 and 2012 the costs exceeded $350 million (Sterling 2014). Finally, in the United Kingdom whiplash personal injury claims exceeded £3 billion per year, whereas in the United States in 2000 the costs of personal injury reached $230 billion (Joslin et al. 2004).

WAD Physiotherapy Management

The management of WAD includes various approaches and techniques, which are based on the severity of patients' symptoms. Except for the medication, which patients usually need in the acute phase of the injury or in a chronic condition so as to minimize the pain (CPA 2005; CSP 2010), a series of exercise therapy sessions or spinal manual therapy sessions are followed. However, various researchers mentioned advice, as the main physiotherapy management approach. In those surveys, many patients report to have positive outcomes with the use of advice from their healthcare professionals (Schmitt et al 2009; Sterling 2011). Furthermore, the interdisciplinary approach appears to be also a useful tool in the management of whiplash injuries (Motor Accidents Authority 2001). Finally, recent surveys refer to the combination of exercise therapy and advice, as one of the most suitable physiotherapy management approaches for the aforementioned disorders (Joslin et al 2004; Elkins 2015).

The aims of the project were to conduct a literature review on various databases and guidelines concerning Chronic WAD, identify the Whiplash Associated Disorders, through diagnosis, scales, physical examination, and present the physiotherapy management of these conditions. Physiotherapy management as exercise programmes and activity, spinal manual therapy, advice, interdisciplinary approach and the combination of exercise programs and advice were examined, so as to highlight the effectiveness of current interventions. The long-term effectiveness of physiotherapy interventions was also examined.

The main hypothesis of the project is that chronic WAD need a combination of therapy techniques and interventions, in order to have an impact on patients' health.

Diagnoses & Prognostic Factors

In 1995, Spitzer et al. presented the Quebec Task Force (QTF) (Table 1), which is the classification model of whiplash injuries and disorders. The Quebec Task Force is a generally accepted whiplash classification method worldwide, which allows practitioners and healthcare professionals to diagnose and categorize patients with whiplash disorders. The grades of the QTF classification represent the severity of clinical symptoms (Rushton et al 2011; Corkery et al 2014), a patient indicates and based on those symptoms, there are five categories (0-IV) of WAD. It is also stated that most patients are classified in WAD I and WAD II classifications (Scholten – Peeters 2002; Sterling 2014).

Table 1. Quebec Task Force (QTF) classification of whiplash associated disorders

QTF classification grade	Clinical presentation
0	No complain about neck pain No physical signs
I	Neck complaint of pain, stiffness or tenderness only No physical signs
II	Neck complaint Musculoskeletal signs including: • Decreased range of movement • Point tenderness
III	Neck complaint Neurological signs including: • Decreased or absent deep tendon reflexes • Muscle weakness • Sensory deficits
IV	Neck complaint and fracture or dislocation

However, apart from the five categories of the QTF classification method, whiplash disorders may also be categorized based on the duration of the symptoms on patients' health. There are three categories concerning the duration of the symptoms, which are acute, subacute and chronic whiplash-associated disorders. Acute WAD is a condition of less than three months of duration, subacute WAD has duration of 3 to 6 months, whereas chronic WAD is a condition of over six months of symptoms' duration (CPA 2005; De Kooning et al 2013).

According to Sterling (2004), the QTF classification has been questioned due to the differences in physical and psychological impairments of individuals who recover from the injury and those who do not. All patients present motor dysfunction, local cervical mechanical hyperalgesia and psychological distress immediate after injury. However, patients who develop persistent pain and disability show a more complex picture concerning the symptoms, with additional impairments, such as non-localised hypersensitivity and posttraumatic stress reaction. Since not all prognostic factors are the same for all patients, there is a difficulty to reliably predict the outcome of whiplash injury (Sterling 2011a).

The recovery of whiplash usually happens during the first 2-3 months following the injury (Kamper et al. 2008). However, there are some prognostic factors that are reported to be related to persistent symptoms and they usually lead to delayed recovery, which is considered to happen over 3 months following the injury. The most important prognostic factor associated with delayed recovery is pain (Sterling 2011c) and then, there are (1) decreased mobility of cervical spine immediately after injury, (2) pre-existing neck trauma, (3) older age and (4) female gender (Scholten-Peeters 2002; Kamper et al. 2008; Sterling 2014). However, recent systematic reviews reported the influence of psychosocial factors in the recovery process, such as fear avoidance, catastrophizing, anxiety and depression (Scholten-Peeters 2002; Sterling 2011a; Corkery et al. 2014).

Physical Examination

The process of the physical examination in patients with WAD is similar to the examination of most cervical spine conditions. The process includes general observation of the patients' body

posture, examination of the active and passive movements of the cervical spine, deep muscles' stability testing of the neck, muscle function, proprioception, neurological tests and palpation of the region (CPA 2005; CSP 2010; Gatterman 2011). The combination of physical examination and subjective assessment enables the physiotherapist to evaluate patients' symptoms, so as to conclude on the categorization of the QTF classification (CSP 2005; Gatterman 2011) as well as to identify some factors that have been related to delayed recovery from WAD (Sterling 2011a; Sterling et al. 2011b).

Scales

Neck Disability Index (NDI) has been established as a valid and reliable scale for assessing the disability of patients with WAD (Vernon 2008; MacDermid et al. 2009). The NDI consists of ten items, which are grading neck-related disability. The grading is from 0, which indicates no activity limitations, to 5, which indicates major activity limitations and the total maximum score could reach 50 points. Therefore, the higher score represents a higher level of disability (Ludvigsson et al. 2015(2)).

Furthermore, Visual Analogue Scale (VAS) is being used in order to assess the pain of the aforementioned patients. It was stated that when initial pain scores of >5.5 on a VAS from 0 to 10, patients tended to have consistent risk factors for poor recovery (Sterling 2014).

Finally, psychosocial factors were reported to influence the patients' condition. The main scales for assessing the psychosocial status of patients with WAD are (1) Pain Catastrophising Scale (PCS), (2) Impact of Events Scale and (3) Hospital Anxiety and Depression Scale (HADS) (Trippolini et al 2012; Van Der Meer et al. 2014; Ludvigsson et al. 2015(2)).

METHODOLOGY & RESOURCES*:*

Research Strategy

A systematic literature review was developed in research data, based on review articles, randomised controlled trials (RCTs) articles, case-control and cohort studies and guidelines of high quality, which have been published during 2000-2015.

Online research was performed in five databases (Pubmed, Cochrane Library, Medline, Pro Quest and PEDro) from November 2015 until January 2016. The terms-keywords used were: (1) "whiplash associated disorders" AND (2) "chronic whiplash syndrome", AND (3) "management of whiplash syndrome" OR "physiotherapy interventions", AND (4) "physiotherapy examination" OR "diagnoses" OR "scales", AND (5) "chronic whiplash and exercise", AND (6) "advice", AND (7) "spinal manual therapy", AND (8) "interdisciplinary approach" and the combination of those. Finally, reference lists' of all identified papers was searched for additional relevant publications in the topic.

Inclusion Criteria

The most important inclusion criteria were that the publications should have been related to WAD. Furthermore, the RCTs included should have used, at least one of the aforementioned techniques as a physiotherapy management approach or the combination of them. Finally, the outcome measures of the studies have assessed the effects of the interventions on minimizing symptoms and augmenting quality of life.

Exclusion Criteria

Publications which included only acute whiplash associated-disorders or subacute whiplash associated-disorders at their research were excluded. Additionally, studies that were not related with physiotherapy management interventions on the aforementioned disorders were excluded. Another exclusion criterion was articles, which were not in English. Finally, studies that were published before 2000 were also excluded.

Data Abstraction & Quality Assessment Tool

Two tables were created, in which there were recorded the data from each study. Tables 2&3 present the study design, diagnosis, population, methodology, results and physiotherapy management intervention of each publication, which were included in this review. Furthermore, in tables 4&5 is presented the rating of the methodological quality of the surveys included, whereas in table 6 the results and the outcome measures of the RCTs used are presented. The rating of the methodological quality of the RCTs was conducted and evaluated by using the 10 criteria of the PEDro Scale. The PEDro scale is a valid measurement tool of the methodological quality of physical therapy clinical trials (De Morton 2009; Elkins et al. 2010). The interpretation of the scores results are "excellent" for studies scoring 9 to 10, "good" from 6 to 8, "fair" from 4 to 5 and "poor" for below 4 scores (Hariohm et al. 2015). Finally, the rating of the methodological quality of some case-control and cohort studies included in the thesis, to describe the categorization of the severity of WAD according to symptomatology and the inter-relationship of the characteristics of patients with WAD, was conducted and evaluated by using the Newcastle-Ottawa scale. The Newcastle-Ottawa scale is a valid and reliable measurement tool of the methodological quality of case-control and cohort studies (Stang 2010; Hartling et al. 2013). The maximum score for a case-control or cohort study is 9 stars.

RESULTS

Description of Studies

The results of the systematic literature review presented sixteen RCTs and seven case-control and cohort studies of single group or more groups design, of both cross-sectional and longitudinal design related to chronic WAD in an attempt to delineate factors related to chronicity of the condition, which fulfilled the inclusion and exclusion criteria of the methodology. The study design, diagnosis, population, methodology, results and physiotherapy intervention of each study included in the survey, were presented in tables 2 and 3. The population of those studies was diagnosed with chronic WAD and the researchers used at least one of the interventions (exercise therapy, spinal manual therapy, interdisciplinary approach, advice or exercise and advice) as a physiotherapy management approach.

Fifteen RCTs (Taimela et al. 2000; Vendrig et al. 2000; Soderlund & Lindberg 2001&2007; Bronfort et al. 2001; Stewart et al. 2003&2007; Hansson et al. 2006; Jull et al. 2007; Vikne et al. 2007; Sterling et al. 2010; Pato et al. 2010; Michaleff et al. 2014; Ludvigsson et al. 2015(1); Elkins 2015) included adults with chronic WAD, whereas one RCT (Lamb et al. 2007) included adults with sub-acute and chronic WAD.

Six case-control and cohort papers (Joslin et al. 2004; Schmitt et al. 2009; Takasaki et al. 2013; Van Der Meer et al. 2014; Ludvigsson et al. 2015(2); Casey et al., 2015) included adults with chronic WAD and one research paper (Sterling et al. 2003) included adults with acute and chronic WAD.

According to Table 2, there were twelve trials comparing two groups, three trials comparing three groups and one trial comparing four groups. Specifically, one trial compared exercise therapy and activity with control group (Hansson et al. 2006), one trial compared spinal manual therapy with control group (Sterling et al. 2010) and one trial compared interdisciplinary approach with control group (Vendrig et al 2000). Two publications compared interdisciplinary approach with exercise therapy (Soderlund & Lindberg 2001&2007) and two trials compared interdisciplinary approach with advice (Jull et al. 2007; Lamb et al. 2007). Additionally, one trial compared exercise therapy with advice (Michaleff et al. 2014), two trials compared exercise and advice with advice (Stewart et al. 2003&2007; Elkins 2015) and one trial compared exercise and advice with exercise therapy (Ludvigsson et al. 2015(1)).

Furthermore, by using three comparing groups, one trial compared local anaesthetic infiltration, medication and exercise therapy (Pato et al. 2010), one trial compared exercise therapy, advice and the combination of exercise therapy and advice (Taimela et al. 2000) and one trial compared exercise therapy, spinal manual therapy and the combination of exercise therapy and spinal manual therapy (Bronfort et al. 2001).

Finally, one trial compared four groups, traditional physiotherapy (Strengthening and Endurance exercises of the neck) at the physiotherapy department and home training, traditional physiotherapy only at home training, sling exercise therapy (Mobilisation and Strengthening exercises) at the physiotherapy department with home training and sling exercise therapy only at home training (Vikne et al., 2007).

Table 2. Study Characteristics and Methods of RCTs (n=16) in Chronic Whiplash Associated-Disorders

Study	Design	Diagnosis	Groups	A.	n	B.	n	C.	n	D.	n
Taimela et al., 2000	RCT Follow up at 12 months	Chronic WAD I-II	3	Exercise therapy (Proprioceptive training, relaxation)	25	Exercise therapy & Advice (Home training, neck lecture, behavioral support)	25	Advice (neck lecture, recommended exercises) –half of the subjects With CBT & half With Out CBT	26	-	-
Vendrig et al., 2000	RCT Follow up at 6 months	Chronic WAD I-II	2	Multimodal physiotherapy (Soft neck collar, Muscle strengthening ex., Aerobic fitness, Endurance ex., Behavioral support, Occupational therapy)	26	Control (no intervention)	25	-	-	-	-
Bronfort et al., 2001	RCT Follow up at 3,6 &12 months	Chronic WAD I-II	3	Exercise therapy (Rehabilitative neck ex.) & Spinal Manual therapy (Manipulation)	64	Exercise therapy (MedX rehabilitative neck ex.)	64	Spinal Manual therapy (Manipulation)	63	-	-
Soderlund & Lindberg 2001	RCT Follow up at 3	Chronic WAD I-II-III	2	Interdisciplinary approach (Physical & Psychological skills) at	16	Exercise therapy (Individualized variety of Exercises & Pain	17	-	-	-	-

Soderlund & Lindberg 2007	months			HOME		control Techniques) at Physiotherapy DEPT. & HOME					
Stewart et al., 2003 Stewart et al., 2007	RCT Follow up at 12 months	Chronic WAD I-II-III	2	Exercise & Advice (Aerobic ex., Strengthening ex. Of the neck & trunk, Endurance ex., Behavioral support)	66	Advice (Neck lecture & Education, Written policies of HOME ex., Behavioral support)	68	-	-	-	-
Hansson et al., 2006	RCT	Chronic WAD II-III	2	Exercise therapy (Vestibular rehabilitation using eye, head & trunk movements, Progression to closed eyes)	16	Control (no intervention)	13	-	-	-	-
Lamb et al., 2007	RCT Follow up at 12 months	Subacute - Chronic WAD I-II-III	2	Interdisciplinary approach (Mobilisation of the cervical & upper thoracic spine, Muscle control ex. Of the cervical, thoracic spine & shoulder region, Cognitive behavioral approach)	300	Advice (Reinforcement of advice, Behavioral approach)	300	-	-	-	-

Jull et al., 2007	RCT	Chronic WAD I-II	2	Multimodal Physiotherapy (Muscle control re-education of the neck & scapula, Functional activities, Posture control, Low velocity mobilization techniques, Education & Advice for HOME training)	36	Advice (HOME activities, Booklet)	35	-	-	-	-
Vikne et al., 2007	RCT Follow up at 12 months	Chronic WAD I-II	4	Traditional Physiotherapy (Strength & Endurance Ex. of the neck, Massage, Manipulation, Acupuncture) & HOME training	53	Traditional physiotherapy (Strength & Endurance Ex. of the neck) only HOME training	55	Sling Ex. Therapy (Mobilisation & Strengthening Ex.) & HOME training	51	Sling Ex. Therapy only HOME training	54
Pato et al., 2010	RCT Follow up at 6 months	Chronic WAD I-II	3	Local anaesthetic infiltration	30	Exercise therapy (Isometric & Low Intensity Isotonic Exercise & Massage & Relaxation techniques, HOME training) & Advice	29	Medication	28	-	-
	RCT		2	Spinal manual therapy	22	Control (Sham	17	-	-	-	-

Sterling et al., 2010		Chronic WAD II-III		(Lateral glide only technique)		Spinal Manual Therapy)					
Michaleff et al., 2014	RCT Follow up at 12 months	Chronic WAD I-II	2	Exercise therapy (Specific cervical spine ex., Posture re-education, Sensorimotor ex., Muscle training)	172	Advice (Behavioral approach, Booklet)	157	-	-	-	-
Ludvigsson et al., 2015 (1)	RCT	Chronic WAD II-III	2	Exercise therapy (Neck-specific ex.) & Advice (Behavioral approach)	70	Exercise therapy (Neck-specific ex.)	68	-	-	-	-
Elkins 2015	RCT	Chronic WAD II-III	2	Exercise therapy (Active neck ex. with increasing resistance, General physical activity, Education)	78	Exercise therapy (Active neck ex. with increasing resistance) & Advice (Pain education, Pain-management skills)	78	-	-	-	-

Finally, concerning the seven case-control and cohort studies (Table 3) the researchers (Sterling et al. 2003; Joslin et al. 2004; Schmitt et al. 2009; Takasaki et al. 2013; Van Der Meer et al. 2014; Ludvigsson et al. 2015(2); Casey et al. 2015) investigated the impact of the related symptoms, such as neck pain, dizziness, unsteadiness, fatigue, psychological factors to the rate of recovery of patients with WAD, to identify factors acting as barriers to the recovery of a proportion of those patients. Based on the results of the aforementioned studies, four surveys (Schmitt et al. 2009; Takasaki et al. 2013; Van Der Meer et al. 2014; Casey et al. 2015) stated pain as the dominant factor in the rate of recovery. Pain is related to disability (Joslin et al. 2004) and functional capacity, as well as to physical and cognitive impairments. Another factor associated to the rate of recovery is the motor system deficits, which are related to moderate/severe symptoms (Sterling et al. 2003). Finally, Ludvigsson et al. (2015(2)) stated that the neck-specific exercises are significantly related to reduction of pain and disability at 3 and 12 months.

Table 3. Study Characteristics of Case-Control & Cohort studies (n=7) examining factors related to delayed recovery in Chronic Whiplash Associated-Disorders

Study	Research Design, Groups Included & Diagnosis	Aim	N	Research Items & Outcome Measures	Results
Sterling et al., 2003	4 group (3 WAD of different disability level & 1 control) - Acute/Chronic WAD II or III - Retrospective Longitudinal	Examination of 1) the motor system & psychological dysfunction and 2) rate of recovery between the groups, at 1-2-3 months post-injury	66	ROM, Pain & Disability with the use of EMG, NDI, ROM & TAMPA questionnaire	In 1 month post injury, there were identified deficits in the motor system that persisted in those reporting moderate/severe symptoms at 3 months, as well as in subjects who recovered and those with persistent mild symptoms.
Joslin et al., 2004	4 groups - Chronic WAD II - Prospective Longitudinal	Comparison of symptoms in patients with fractures of the cervical spine (no neurological deficit) and patients with whiplash injury (matched age & gender)	80 patients with 3.5 years of follow up	Pain and Disability with the use of NDI & VAS	Patients pursuing compensation after whiplash injury had greater disability than those who have had a fracture of the cervical spine or those with a whiplash injury without litigation
Schmitt et al., 2009	Single group - Chronic WAD II - Cross-Sectional Study	Examination of the relative contribution of cervical impairments and psychological factors in disability	86	Psychological factors & Disability with the use of NDI, HADS, PCCL, C-AROM	The Pain-related catastrophizing explained the variance in perceived neck disability and active range of cervical motion (to a lesser extent)
	Single group - Chronic WAD	Investigation of the contribution of physical, cognitive &	40	Pain and Disability with the use of NPDI,	Both Physical and Cognitive impairments, independently, contributed to

Takasaki et al., 2013	II-III - Cross-Sectional Study	psychological factors in self-reported driving difficulty after adjusting for neck pain, dizziness and relevant demographics		ROM, VAS, Dizziness Handicap Inventory, GHQ-28	self-reported driving difficulty in patients with chronic WAD, beyond neck pain, dizziness and symptoms' duration.
Van Der Meer et al., 2014	Single group - Chronic WAD I-II - Cross-Sectional Study	Investigation of the relationship between self-reported disability & functional capacity	40	Disability and Functional Capacity with the use of NDI, FCE & NRS	Self-reported disability and functional capacity are related differently. Both can be predicted by pain intensity. But a pending claim can predict higher self-reported disability.
Ludvigsson et al., 2015 (2)	3 group RCT - Chronic WAD II-III - Secondary analysis with Multivariate Logistic Regression	Identification of patient baseline features and types of treatment as predictors of response to treatment	202	Pain, Disability & Self-Efficacy with the use of NDI & VAS	The neck-specific exercise group was the only significant factor associated with neck pain & disability reduction both at 3 and 12 months. Those patients had up to 5.3 times higher odds of disability reduction and 3.9 times higher odds of pain reduction compared to those in the physical activity group.
Casey et al., 2015	Chronic WAD - Prospective Cohort study	Examination of disability, pain, catastrophizing and mental health as predictors of	246 patients, follow-up of 24 months	Disability, Pain & Mental Health with the use of	The predictors of the severe disability patients-group showed: lower pain scores (SF36 $p \leq 0.01$);

		the course of WAD		FRI, PCS & SF36	high pain catastrophizing (p≤0.01) and, poor general health (p=0.03).

NDI: Neck Disability Index; ROM: Range of Motion; VAS: Visual Analogue Scale of pain; TAMPA: TAMPA Scale for Kinesiophobia; HADS: Hospital Anxiety & Depression list; PCCL: Pain Coping & Cognition Questionnaire; C-AROM: Cervical Range of motion device; NPDI: Neck Pain Driving Index; GHQ-28: 28-item General Health Questionnaire; FCE: Functional Capacity Evaluation; NRS: Numeric Rating Scale; FRI: Functional Rating Index; PCS: Pain Catastrophizing Scale; SF36: Mental Component Score

Qualitative Assessment

The 10 criteria of PEDro scale were used in order to evaluate the methodological quality of the RCTs (n=16), included in the survey. In table 4 the evaluation of each included publication is presented. Five studies (Stewart et al. 2003&2007; Jull et al. 2007; Michaleff et al. 2014; Elkins 2015) were assessed between 9 to 10, so they were considered as methodologically "excellent". Finally, eleven studies (Taimela et al. 2000; Vendrig et al. 2000; Bronfort et al. 2001; Soderlund & Lindberg 2001&2007; Hansson et al. 2006; Lamb et al. 2007; Vikne et al. 2007; Pato et al. 2010; Sterling et al. 2010; Ludvigsson et al. 2015(1)) were assessed between 6 to 8, so they were considered as methodologically "good".

Table 4. PEDro Scale Scores of the RCTs in Chronic Whiplash Associated-Disorders

Study	Score										Total
Taimela et al., 2000	1	0	1	1	0	0	1	1	1	1	7
Vendrig et al., 2000	0	0	1	1	1	0	1	0	1	1	6
Bronfort et al., 2001	1	0	1	1	0	0	1	1	1	1	7
Soderlund & Lindberg, 2001&2007	1	0	1	1	0	0	0	1	1	1	6
Stewart et al., 2003&2007	1	1	1	1	1	0	1	1	1	1	9
Hansson et al., 2006	1	0	1	1	0	0	1	1	1	0	6
Lamb et al., 2007	1	0	1	1	0	0	0	0	1	1	5
Jull et al., 2007	1	0	1	1	1	1	1	1	1	1	9
Vikne et al., 2007	1	0	1	0	0	1	1	1	1	0	6
Pato et al., 2010	1	0	1	1	1	0	0	1	1	1	7
Sterling et al., 2010	1	0	1	1	0	0	1	1	1	1	7
Michaleff et al., 2014	1	0	1	1	1	1	1	1	1	1	9
Ludvigsson et al., 2015 (1&2)	1	1	1	1	0	0	0	1	1	1	7
Elkins, 2015	1	1	1	1	1	1	0	1	1	1	9

Furthermore, the criteria of the Newcastle-Ottawa Scale were used in order to evaluate the methodological quality of the case-control & cohort papers (n=7) included. In table 5, the evaluation of the papers is presented in detail. The results indicated that the aforementioned papers were of high methodological quality.

Table 5. Newcastle-Ottawa Scale Case-Control & Cohort Studies Star Template in Chronic Whiplash Associated-Disorders

Study	Selection	Comparability	Exposure/Outcome	Score
Sterling et al., 2003	★★★	★★	★★	7 stars
Joslin et al., 2004	★★★	★★	★★	7 stars
Schmitt et al., 2009	★★★★	★★	★★★	9 stars
Takasaki et al., 2013	★★★	★★	★★★	8 stars
Van Der Meer et al., 2014	★★★	★★	★★★	8 stars
Casey et al., 2015	★★★★	★★	★★★	9 stars

Outcome Measures

The assessment of patients with chronic whiplash associated-disorders, in all studies was conducted by using various WAD tests and scales. In table 6 was recorded the statistically significant results (p values) and the statistically significant comparison between the groups of each study.

Neck Disability Index (NDI)

Ten studies (Sterling et al. 2003; Joslin et al. 2004; Jull et al. 2007; Stewart et al. 2007; Lamb et al. 2007; Schmitt et al. 2009; Takasaki et al. 2013; Ludvigsson et al. 2015(1); Van Der Meer et al. 2014; Elkins 2015) used the NDI scale to assess the participants' performance after several interventions. The NDI has been established as a valid and reliable scale for assessing the disability of patients with WAD (Vernon 2008; MacDermid et al. 2009) and it appeared statistically significant results ($p<.01$) on the assessment of various interventions.

Visual Analogue Scale (VAS)

Seven studied (Vendrig et al. 2000; Taimela et al. 2000; Stewart et al. 2003; Pato et al. 2010; Takasaki et al. 2013; Ludvigsson et al. 2015 (1); Elkins 2015) used the VAS scale, in order to assess the pain of the participants. The reliability of the VAS scale has been reported by Ludvigsson et al. 2015(1) ($p=.04$).

Psychosocial factors

Eleven studies (Taimela et al. 2000; Vendrig et al. 2000; Sterling et al. 2003; Stewart et al. 2007; Soderlund & Lindberg 2001&2007; Schmitt et al. 2009; Sterling et al. 2010; Pato et al. 2010; Casey et al. 2015) used various scales in order to assess the psychosocial status of the participants, such as the Pain Catastrophising Scale, the Pain intensity & Disability Scale (NRS) and the HADS Scale. All of the aforementioned scales appeared to have excellent reliability and validity and statistically significant outcome measures for each intervention.

Functional Ability

Seven studies (Vendrig et al. 2000; Bronfort et al. 2001; Stewart et al. 2003; Hansson et al. 2006; Soderlund & Lindberg 2007; Van Der Meer et al. 2014; Casey et al. 2015) also examined the functional ability with reliable scales such as Functional Capacity (FCE), and DHI functional of the participants following the interventions. The results of the aforementioned studies indicated that the functional ability of participants meliorated following the interventions.

Table 6. Outcome Measures & Results of RCTs (n=16)

Study	Outcome Measures	Significant Difference	No Significant Difference	Results (Suitable Intervention)
Taimela et al., 2000	1. VAS 2. Pain Catastrophising Scale	Significantly Greater Improvement in group A: VAS (p<.01-.03) Pain Catastrophising Scale (p<.001) At 3 months Improvement in group A: VAS (p=0.007) Pain Catastrophising Scale (p=0.073) At 12 months **Between-group Differences** In favor of group A: VAS difference 12.1 (p=.002) Pain Catastrophising Scale difference 10.4 (p=.005) At 3 months VAS difference 10.0 (p=.007) Pain Catastrophising Scale difference 7.6 (p=.022) At 12 months		**Exercise therapy (Proprioceptive training, relaxation)**
Vendrig et al., 2000	1. VAS 2. Disability (QBPDS) 3. Depression (MMP12 Hy3)	Significantly Greater Improvement in group A: VAS (p<.01) Disability (p<.001) Depression (p<.001) At 6 months **Between-group Differences**		**Multimodal physiotherapy (Soft neck collar, Muscle strengthening ex., Aerobic fitness, Endurance ex., Behavioral support,**

		No group differences in population (p>.05) In favor of group A: VAS 3.1 (p<.01) Disability 4.8 (p<.001) Depression 5.7 (p<.001) At 6 months		**Occupational therapy)**
Bronfort et al., 2001	1. VAS 2. Neck Disability Index (NDI) 3. Short Form 36 (SF-36)	Significantly Greater Improvement in group A in relation to groups B&C: NDI (p<.05) SF-36 (p=.03) At 3 months Improvement in group A: VAS (p=.02) At 6 months **Between-group Differences** In favor of group A: VAS 3.3 (p=.04) SF-36 4.5 (p=.01) At 3 months In favor of group A: VAS 4.2 (p=.02) At 6 months	No significant differences between groups: NDI 2.04 (p=.13) SF-36 2.5 (p=.09) At 6 months No significant differences between groups p=.01 At 12 months	**Exercise therapy (Rehabilitative neck ex.) & Spinal Manual therapy (Manipulation)**
Soderlund & Lindberg 2001 Soderlund & Lindberg 2007	1. NRS pain intensity 2. PDI disability relater to chronic pain 3. Patient perception of treatment (7 questions)	Significantly Greater Improvement in group A: NRS (p<.05) Post-treatment Patient perception of treatment (p<.05) at 6 months Significantly Greater Improvement in group B: PDI (p<.05) At 3 months **Between-group Differences** No between-groups differences stated at		**Interdisciplinary approach (Physical & Psychological skills) at HOME**

		6 months follow up in the second trial		
Stewart et al., 2003 Stewart et al., 2007	1. VAS 2. Functional Ability (PSFS)	Significantly Greater Improvement in group A: VAS (p=.005) PSFS (p=.006) At 6 weeks ONLY/ not at 12 months **Between-group Differences** In favor of group A: VAS 9.9 (p=.05)		**Exercise & Advice (Aerobic ex., Strengthening ex. Of the neck & trunk, Endurance ex., Behavioral support)**
Hansson et al., 2006	1. Tandem standing with eyes open then closed for 30 seconds 2. SOLEO 3. Walking in a Figure of 8 with steps outside of the figure counted 4. Walking line 5. DHI (functional, emotional and physical)	Significantly Greater Improvement in group A: Tandem standing – closed eyes (p=.045) At 6 weeks SOLEO (p=.02) At 6 weeks & at 3 months DHI (p=.047) At 6 weeks total, (p=.005) functional, (p=.033) physical At 6 weeks & at 3 months **Between-group Differences** No between-groups differences stated		**Exercise therapy (Vestibular rehabilitation using eye, head & trunk movements, Progression to closed eyes)**
Lamb et al., 2007	1. Neck Disability Index (NDI) 2. EQ-5D	Significantly Greater Improvement in group A: NDI (SD=0.375) **Between-group Differences** No between-groups differences stated	No significant differences between groups: EQ-5D (SD=0.02)	**Interdisciplinary approach (Mobilisation of the cervical & upper thoracic spine, Muscle control ex. Of the cervical, thoracic spine & shoulder region, Cognitive behavioral approach)**
				Multimodal Physiotherapy (Muscle control

Jull et al., 2007	1. Neck pain and disability (NPI) 2. Cervical muscle test (CCFT) 3. Psychological tests: GHQ-28 IES TAMPA	Significantly Greater Improvement in group A: NPI (p=.04) CCFT (p<.018) **Between-group Differences** In favor of group A: NPI 0.9 (p=.05)	No significant differences between groups GHQ-28 (p=.28) IES (p=.15)	**re-education of the neck & scapula, Functional activities, Posture control, Low velocity mobilization techniques, Education & Advice for HOME training)**
Vikne et al., 2007	1. VAS 2. Psychological distress HSCL 3. Neck stabilization/ endurance hold in seconds	Significantly Greater Improvement in group A: Neck stabilization/ endurance hold in seconds (p=.01) At 12 months **Between-group Differences** No between-groups difference stated	No statistically significant differences between groups (p=.07 to .82) except for small effect for home training on pain during rest (p=.05) and reported fatigue (p=.02) At 4 months	**Exercise therapy (Strength & Endurance Ex. of the neck, Massage, Manipulation, Acupuncture) & HOME training**
Pato et al., 2010	1. Pain McGill 2. VAS 3. HAQ 4. Well Being Scale 5. CFQ to evaluate cognitive ability	Significantly Greater Improvement in group B: VAS (p=.05) ONLY in FEMALE population **Between-group Differences** In favor of group A: VAS 0.8 (p=.05)	No statistically significant difference in efficacy between the 3 interventions	**Exercise therapy (Isometric & Low Intensity Isotonic Exercise & Massage & Relaxation techniques, HOME training) & Advice**
Sterling et al., 2010	1. PPT (cervical spine, median nerve, Tibialis Anterior Sites) 2. TPT (hot & cold thresholds at C_{5-6}) 3. NFR threshold pain rating 4. VAS	Significantly Greater Improvement in group A: NFR (p=.04) **Between-group Differences** In favor of group A: NFR 0.8 (p=.05)	No significant differences between groups PPT (p=.78) cervical spine, (p=.068) median nerve, (p=.49) Tibialis Anterior Sited TPT (p=.55) heat (p=.48) cold VAS (p=.063)	**Spinal manual therapy (Lateral glide only technique)**

Michaleff et al., 2014	1. Neck Disability Index (NDI) 2. VAS 3. Functional Ability	No between-group differences stated	No significant differences between the groups: NDI (p=0.48) VAS (p=0.228) Functional Ability (p=0.259)	**Exercise therapy (Specific cervical spine ex., Posture re-education, Sensorimotor ex., Muscle training) & Advice (Behavioral approach, Booklet)**
Ludvigsson et al., 2015 (1)	1. VAS 2. Neck Disability Index (NDI)	Significantly Greater Improvement in group B: At 3 months NDI (p=.04) VAS (p=.02) At 12 months NDI (p<.01) VAS (p=.01) **Between-group Differences** No significant differences between-groups stated		**Exercise therapy (Neck-specific ex.) & Advice (Behavioral approach)**
Elkins 2015	1. Neck Disability Index (NDI) 2. VAS	Significantly Greater Improvement in group A: NDI (MD=2.3, 95%) VAS (>50% reduction of pain)	Unclear Benefit of Advice	**Exercise therapy (Active neck ex. with increasing resistance, General physical activity, Education)**

Primary Outcomes

The primary outcomes indicated six studies, which stated Exercise & Advice, as the most suitable intervention about the management of patients with WAD, concerning the scores of NDI, VAS, Psychosocial Scales and Functional Ability scales. However, four studies reported Exercise therapy as the most effective intervention on those patients, whereas three studies reported Interdisciplinary approach to be the intervention that minimizes the symptoms and two studies mentioned Multimodal Physiotherapy treatment. Finally, one study indicated the combination of Exercise therapy & Spinal Manual Therapy as the most suitable intervention, whereas one study indicated Spinal Manual Therapy.

DISCUSSION

Summary of Evidence

Overall, the evidence suggests that the combination of Exercise & Advice is more effective than other interventions in improving pain, functional ability and dysfunction in patients with chronic WAD grades I-III. However, the effects of other interventions should be mentioned, since their impact in the short term is evident.

Exercise & Advice

Six publications (Stewart et al. 2003&2007; Pato et al. 2010; Michaleff et al. 2014; Ludvigsson et al. 2015{1&2}) recommended Exercise & Advice, as the most suitable intervention concerning the physiotherapy management of patients with chronic WAD. Especially, three RCTs (Stewart et al. 2003&2007; Michaleff et al. 2014) had a follow up at 6 & 12 months. Stewart et al., both at 2003 and 2007, used the same population in order to evaluate the effectiveness of a similar exercise programme in patients with WAD I-III, which included aerobic exercises, strengthening exercises of the neck and trunk and endurance exercises with the combination of behavioral approach. However, the results indicated significantly greater improvement in VAS and PSFS only at 6 months comparing to advice. Several years later, Michaleff et al. (2014) examined the impact of specific cervical spine exercises, postural re-education, sensorimotor exercises, and muscle training exercises with the use of behavioral approach in patients with WAD I-II in comparison to advice only. The positive impact in patients with WAD I-II was also evident in the study of Pato et al. (2010), where the implementation of isometric and low intensity isotonic exercises, massage and relaxation techniques with behavioral approach, in comparison to two medication groups, minimized the symptoms. Finally, Ludvigsson et al (2015), in both studies, presented the effectiveness of neck-specific exercises and education in the reduction of pain and disability.

Exercise Therapy

Four studies (Taimela et al. 2000; Hansson et al. 2006; Vikne et al. 2007; Elkins 2015) examined the impact of Exercise therapy in patients with WAD I-III. Taimela et al. (2000) and Vikne et al. (2007) used different Exercise therapy programmes with a follow up at 12 months in patients with WAD I-II. The first research group implemented proprioception training and relaxation techniques, whereas the second implemented a programme with strength and endurance exercises of the neck, massage, manipulation, acupuncture and home training exercises. The results of the first trial showed significant improvement in VAS and Pain Catastrophising scale long-term, compared to the second trial. Concerning the patients with WAD of grades II-III, Hansson et al (2006) implemented vestibular rehabilitation using eye, head and trunk movements with progression to closed eyes, which improved the Functional scales (SOLEO, DHI) measurements of the participants. Finally, Elkins (2015) used active neck exercises with increasing resistance, general activity and education vs. Exercise & Advice and the outcome measures indicated significantly greater improvement in VAS, NDI and Self-Efficacy scales.

Interdisciplinary Approach vs. Multimodal Physiotherapy Treatment (P/T)

The use of interdisciplinary approach as an intervention in patients with WAD was examined by three publications (Soderlund & Lindberg 2001&2007; Lamb et al. 2007), whereas the intervention of multimodal P/T was examined by two (Vendrig et al. 2000; Jull et al. 2007). Soderlund & Lindberg by conducting the same trial in 2001 and in 2007, with a follow up at 3 months at the second time, stated that physical activity and psychological skills at home were

more effective than individualized variety of exercises and pain control techniques at home and physiotherapy department. The results indicated significantly greater improvement in the group which received the interdisciplinary approach, since the NRS pain intensity ($p<.05$) declined. The same year, Lamb et al. examined the effectiveness of the interdisciplinary approach, with a follow up at 12 months. The programme included mobilisation of the cervical and upper thoracic spine, muscle control exercises of the cervical, thoracic spine and the shoulder region with the combination of cognitive behavioral approach, and the outcome measures of the trial presented significantly greater improvement in NDI scale in favor of the interdisciplinary approach.

Nevertheless, the effects of Multimodal P/T were more concerning the pain and disability, comparing the interdisciplinary approach in grades I-II of WAD. In 2000, Vendrig et al. implemented a multimodal therapy with follow up at 6 months, which included muscle strengthening exercises, aerobic fitness, soft neck collar, endurance exercises, behavioral support and occupational therapy. The significantly improvement in VAS ($p<.01$) and Disability (QBPDS) ($p<.001$) in the long-term (6 months), indicated the effects of the therapy. Furthermore, Jull et al. (2007) used a different multimodal approach with muscle control re-education of the neck and scapula, functional activities, posture control, low velocity mobilization techniques, education and advice for home training. Although, the improvement in NPI and Cervical Muscle Test was significant, the intervention did not state any improvement in the psychological status of the participants.

Exercise Therapy & Spinal Manual Therapy vs. Spinal Manual Therapy

Overall, two trials examined the effectiveness of Spinal Manual Therapy with or without the combination of Exercise therapy, which were assessed as methodologically "good". The combination of Spinal Manual therapy with Exercise therapy was examined by Bronfort et al (2001), who used rehabilitative neck exercises and manipulation with a follow up of 3,6 and 12 months in order to assess the effectiveness of the intervention in pain, functional disability and psychological status. The findings presented improvement in NDI and SF-36 scores at the 3 months follow up, whereas at 6 months follow up there was an improvement in VAS scores. On the contrary, Sterling et al (2010) used 3 sets of lateral glide techniques only in patients with WAD II-III, which presented a short term improvement in NFR threshold pain rating only, without further positive effects in the participants.

Strengths & Limitations

During the literature review, there were used clear case definitions, inclusion and exclusion criteria for the selection of the studies, as well as studies with adequate sample sizes and high methodologically quality.

However, all of the studies included participants with chronic WAD grades I-III and no study included participants with grade IV symptoms. Furthermore, the outcome measures of all studies stated significantly important and not clinically important results.

CONCLUSION

The physiotherapy management of patients with WAD grades I-III is a complicated and discussed matter. According to the findings of this literature review, the most suitable intervention is the combination of Exercise & Advice, where the outcome measures of certain

scales (NDI, VAS, NFR, SF-36, HADS scale) appeared positive results. However, the aforementioned intervention is not the only intervention mentioned with evident effects in patients in a short time period.

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