Research Article Open Access

An Investigation into the Range of Movement and Forces Involved by the Application of Wrist Flexion Restraint Techniques - Pain Inducing or Not?

Barnett R[*1], Bower E[1], Chan A[1] and Stirling C[2]

[1]School of Health and Rehabilitation, Keele University, Keele, England
[2]Faculty of Education, Health and Wellbeing, Wolverhampton University, England

[*]**Corresponding author:** Barnett R, Lecturer, Member of: Restraint Advisory Board, Independent Restraint Advisory Panel, Serious Injuries and Warning Signs Committee (Ministry of Justice), School of Health and Rehabilitation, Keele University, Newcastle-Under-Lyme, ST5 5BG, Staffordshire, England, Tel: 07729989934, Email: r.j.barnett@keele.ac.uk

Citation: Barnett R, Bower E, Chan A, Stirling C (2018) An Investigation into the Range of Movement and Forces Involved by the Application of Wrist Flexion Restraint Techniques - Pain Inducing or Not?. J Emerg Med Care 1(2): 203

Abstract

Although the use of physical restraint (PR) is accepted, it remains controversial as staff are required to balance professional, ethical and legal tensions between maintaining everyone's safety, upholding human rights, and minimising harm. One such tension relates to the use of Wrist Flexion Techniques (WFT) used in some health, social care and custodial settings. WFT impose load onto the musculoskeletal structures of the wrist to gain control or compliance from a restrained person, and can result in discomfort, pain, injury, psychological trauma and be detrimental to therapeutic relationships. Current evidence and guidance on WFT are absent with debate existing as to whether WFT can be used without inducing pain. Twenty adults participated in the study. The mean discomfort angle was 90.1° (± 8.6) of flexion with 2.8 Kg (± 1.1) of force, and the mean pain angle was and 98.4° (± 7.9) of flexion with 4.4 Kg (± 1.8) of force, therefore only 8.3° of movement and 1.6 Kg of force separate pain free from pain inducing WFT. Genders did not differ in relation to angle of discomfort or pain. Females experienced discomfort with 1.1Kg less force ($p = 0.021$) and experienced pain with 1.7Kg less force ($p = 0.023$). This research challenges the assertion that WFT can exist as non-pain inducing and pain inducing PR techniques since the margin between them may be too small for practitioners to discriminate, particularly during the struggle of real world restraint. Further research may consider other potential pain inducing techniques, and the role and use of PIT during restraint.

Keywords: Wrist; Radiocarpal; Flexion; Volar Flexion; Pain; Compliance; Injury; Restraint

Introduction

This research will be of interest to those who work in, commission or monitor settings where staff are trained to use restrictive physical interventions (physical restraint). Physical Restraint (PR) is a manual, hands-on method of immobilising an individual or limiting their freedom to move to prevent or reduce their ability to harm themselves or others (Restraint Advisory Board 2011; DH 2015; NICE 2015) [1,2]. Across most settings where PR is used, efforts have been made to minimise its use and improve guidance for staff (RAB 2011; MMPR 2012; MIND 2013 ; BILD 2014; NICE 2015; DH 2014 ; Hucksorn 2015) [1-6]. Rather than being an effective clinical or therapeutic intervention, PR is recognised as a short-term and last resort emergency intervention to manage crisis behaviour and minimise harm (Allen *et al.*, 2009; Tenneij and Koot 2008; Heyvaert *et al.*, 2014a) [7-9]. Critics of PR suggest that it does not help staff to find solutions to the underlying causes of the individual's behaviour and may cause trauma and / or re-traumatise those with a history of physical and/or sexual abuse (Hawkins *et al.*, 2004 [10], Smallridge & Williamson, 2011, DOH 2012 , MIND, 2013 and 2015, Heyvaert *et al.*, 2014b, Merineau-Cote and Morin, 2014, YJB, 2014 , 2015, 2016, Campbell, 2018 , Muir-Cochrane *et al.*, 2013, Farina-Lopez *et al.*, 2014, Farina *et al.*, 2016) [4,10-20]. Such factors mean PR remains contentious and has been described as a "necessary evil" (Wilson *et al.,* 2017) [21].

Additionally, concerns about the use of PR also exist in relation to physiological and anatomical risks related to specific techniques or interventions including techniques which induce pain and/or are more likely to lead to soft tissue injury, articular damage, fractures and even death (DH 2006 and 2014; Care Quality Commission 2011; Duxbury *et al.*, 2011; Barnett *et al.*, 2012) [5,22-25].

To reduce the risk of harm and minimise trauma, pain inducing techniques (PIT) have been questioned generally (Patterson, 2005) and specifically in relation Wrist Flexion Techniques (WFT) (Strubbs and Hollins 2011) as to their appropriateness as a means of containment and / or gaining compliance from a restrained individual [26,27]. WFT may represent a potential breach of Article 3 of the Human Rights Act (1998) if pain is induced intentionally, by misapplication, or simply because the restraint technique is known to possess a small margin for error between being pain free and pain inducing, unless it can be shown to be necessary and reasonable. Many restraint training programmes in the UK are accredited by the National Physical Interventions Accreditation Scheme (PIAS) (BILD 2014) and are already required to omit containment/holding techniques which might increase the likelihood of injury and/or pain by application or misapplication. Although the scheme is due to expand to all adult health and social care setting in 2019, currently the PIAS only relates to services for children and adults with intellectual disabilities, cognitive impairment and Autism, and therefore does not cover mental health or custodial settings where WFT that induce pain intentionally and unintentionally are used. Some programmes not currently accredited under the PIAS scheme and which include the use of PIT accept such interventions create professional, ethical and legal dilemmas for staff and acknowledge that future research is required to adapt and evolve restraint training systems so that PIT can be removed from practice (RAB 2011; MMPR 2012, HMIPs, 2015 and 2017) [1,3,28,29]. Whilst recent guidance gave some clarification regarding the context for the use of PIT by suggesting pain should only be used where there is an immediate risk to life (NICE, 2015; DH, 2015), there is no universal definition of what constitutes a PIT and no universal safeguards to protect individuals from the misuse and abuse of such techniques [2].

In addition to a lack of clarity in defining PR and the use of PIT, there is no national data collection system across services in the UK which enables the adverse outcomes arising from the use of PR to be captured and analysed. Data recently published by the Youth Justice Board (YJB) showed there had been 2,475 use of force incidents (25.4 to 30.6 per 100 young people across five secure establishments) and 1,439 uses of PR, resulting in 111 injuries including one wrist fracture (YJB 2014; 2015; 2016) [15-17]. YJB data also showed that PIT accounted for 3% of PR use, with holds involving flexion of the wrist being amongst the most commonly used PR techniques. Given the use of WFT across some health, social care and custodial settings, the potential for causing pain or injury and the assertion that WFT can be used with and without the deliberate infliction of pain or harm (MMPR 2012), the use of WFT as a safe and appropriate restraint technique is worthy of research and challenge. Following a Freedom of Information (FOI) request from every NHS Mental Health Trust in England, Campbell (2018) reported that between 2016-17 some 13% of NHS Trusts did not have a policy or guidance on the use of restraint and of 97,019 incidents of restraint reported, a total of 3,652 resulted in restraint-related injuries to patients [3,18]. In contrast to the data from the YJB, the NHS data set does not report on the use of PIT so the number of patients subject to pain, deliberately or otherwise, is not known. Although the FOI revealed the highest number of reported injuries ever recorded for patients, there remain many discrepancies on the reporting and recording of restraint across the NHS and more work is required to establish a reporting system based on universal definitions and more accurate recording of techniques to determine whether staff are using PIT intentionally or unintentionally. By investigating the ranges of movement and forces involved in the application of WFT in the form of the Inverted Wrist Hold (IWH) and the PIT known as Wrist Flexion (PITWF) where flexion continues further than in the IWH until pain is induced, this research aimed to both inform the teaching of and challenge the acceptability off WFT as a method of PR.

Materials and Methods

Ethical Issues

Ethical approval was granted by the School of Health and Rehabilitation Ethics Committee (Keele University, Newcastle-Under-Lyme, United Kingdom). Participants signed to give valid consent, and no incentives were offered or given to participants

Participants

Twenty adults, 10 male and 10 female were recruited from Keele University via poster advertisement and emails sent to all students in the School of Health and Rehabilitation. All participants were required to give informed consent and be free from current or previous neuro-musculo-skeletal injuries of the elbow, wrist or hand, not diagnosed with hypermobility syndrome, and have the ability to feel pain in a similar way to others. Participants mean age was 21 (± 2.87) range 19-29 years, mean height was 167.6 (± 7.19) range 156.4 - 180.1 cm, mean weight was 63.6 (± 8.62), range 47 to 80 Kg, and mean BMI was 22.6 (± 2.41), ranged 17.7 - 27.2. Right hand dominance was present in 18 participants.

Equipment

An Electronic Goniometer (Twin Axis Goniometer Biometrics Ltd 'SG' series) was used to measure range of flexion (degrees), a Hand Held Electric Myometer (Biometrics Ltd M550 Myometer) was used to measure force applied (Kgs), and the Biometrics DataLOG (Biometrics Ltd., version 10.05, Wales) processed inputs (Figure 1a). Other equipment included SECA 220 standiometer (height) and SECA 761 scales (weight). All equipment was freely available from the School of Health and Rehabilitation, Keele University, UK [30].

Figure 1a: Twin Axis Electronic Goniometer (front left). Electronic Myometer (front right). DataLOG (back centre) used to gather data

Conduct of the Study

Before data was collected from a participant all equipment was calibrated and cleaned. All Participants were tested individually. On arrival participants' height (cm), weight (Kg) and BMI were recorded. Participants then sat next to a plinth adjusted to achieve approximately ninety degrees elbow flexion when participants placed their dominant forearm / hand on it, in a supinated position. The Electronic Goniometer was attached to the participant's wrist using double sided tape on skin cleaned with alcohol wipes. One point was attached along the medial border of the 5th metacarpal and the other was attached along the medial border of the ulna (Figure 1b).

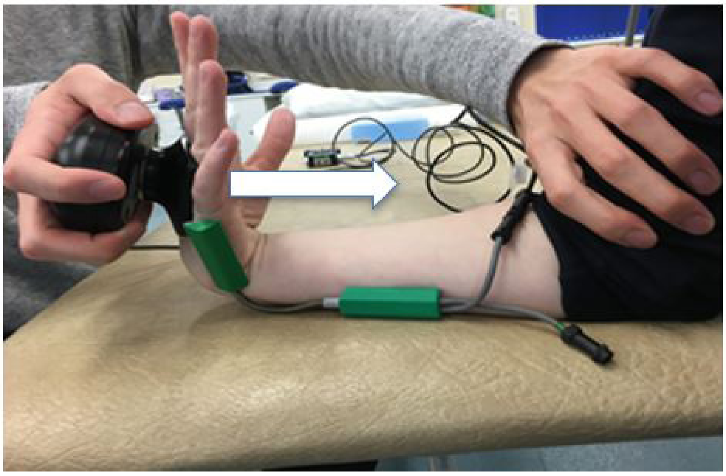

Figure 1b: Twin Axis Electronic Goniometer Attachment and Application of Wrist Flexion Using the Electronic Myometer. Arrow indicates direction of force application by researcher

Before data collection began participants were given descriptors for discomfort and pain with 'discomfort' defined as "a point where you can feel a stretch on your wrist but you are able to move further into flexion (wrist bent towards you)"; and pain as "a point at which you feel actual pain and feel you can no longer can move into further flexion (wrist bent towards you)". Participants were also reminded that at any point they could stop the experiment. From a neutral position a flexion force was applied via the hand held Electric Myometer to the dorsal aspect of the participants hand centred over the midpoint of the third metatarsal (Figure 1b). When a participant stated they felt "discomfort" the extent of wrist flexion (in degrees) and force (in Kg) being applied was recorded, then with consent, further flexion was gradually applied until the participant stated that they felt "pain" at which point the extent of wrist flexion (in degrees) and force (Kg) was again recorded after which, flexion was released and the participant's wrist returned to neutral.

Statistical Analysis

The data collected was analysed using Statistical Packages for the Social Sciences Statistics (IBM Corp. version 24.0, Chicago, Illinois, USA). Normal distribution of data was confirmed (Shapiro-Wilk test) and subsequently descriptive and inferential (Independent t-test) statistical analysis was undertaken, with significance set at $p < 0.05$.

Results

The mean angle of wrist flexion at which discomfort was reported was 90.1° (± 8.6), minimum 73°, and maximum 112°. The mean angle of wrist flexion at which pain was reported was 98.4° (± 7.9), minimum 85°, and maximum 115°. The mean force applied during wrist flexion at which discomfort was reported was 2.8 Kg (±1.1), minimum 1.2 Kg, and maximum 5.6 Kg. The mean force applied during wrist flexion at which pain was reported was 4.4 Kg (± 1.8), minimum 2.5 Kg, and maximum 8.1 Kg (Table 1, Figure 2a and b). The difference in mean angle between discomfort and pain was 8.3° of flexion and 1.6Kg of force. There is overlap in discomfort and pain perception with the highest discomfort angle being 112o and the lowest pain angle being 85o and the highest discomfort force being 5.6 Kg and the lowest pain force being 2.5 Kg.

	Discomfort Reported (degrees)	**Pain Reported (degrees)**	**Discomfort Reported (Kg force)**	**Pain Reported (Kg force)**
Mean (SD)	90.1 (± 8.6)	98.4 (± 7.9)	2.8 (± 1.1)	4.4 (± 1.8)
Minimum	73.0	85.0	**1.2**	*2.5*
Maximum	112.0	115.0	5.6	8.1
Range	**39.0**	30.0	4.4	5.6

Table 1: Descriptive Statistics - Degrees of Wrist Flexion and Force Applied and Reporting of Discomfort and Pain

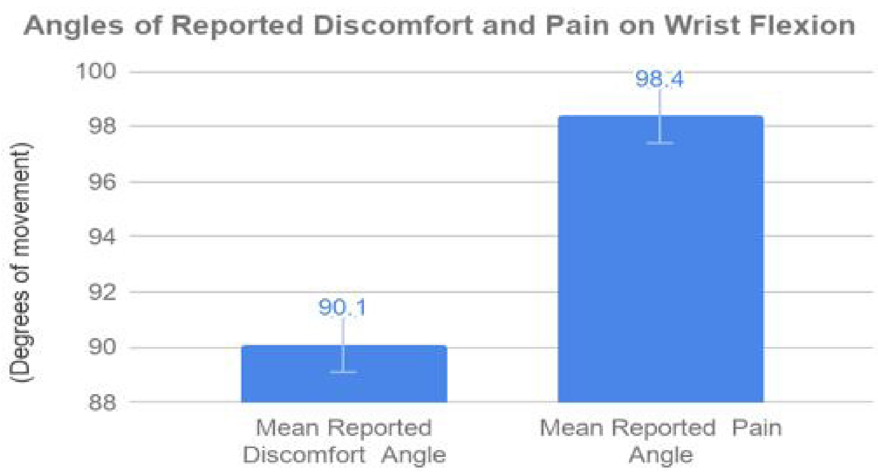

Figure 2a: Degrees of Wrist Flexion applied on the Reporting of Discomfort and Pain

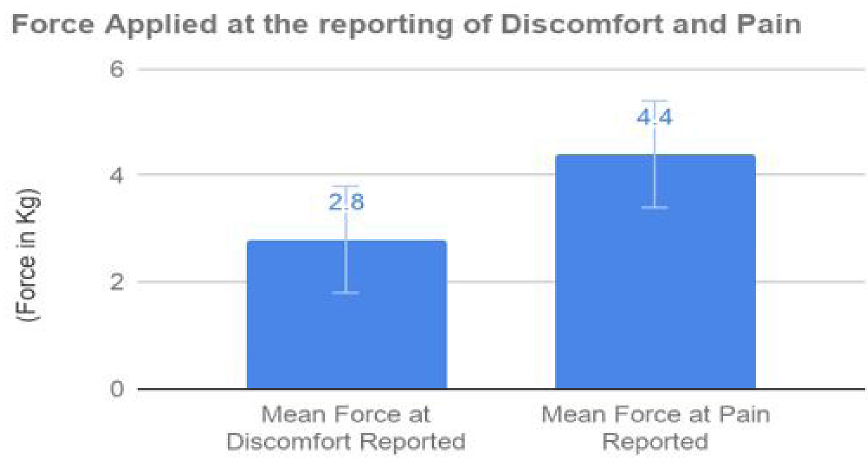

Figure 2b: Mean Force applied on the Reporting of Discomfort and Pain

Males had a mean discomfort angle of 89.6° (±7.2) and females 90.5° (±10.1) and males had a mean pain angle of 98° (±8.6) and females 98.7° (±7.6) (Table 2, Figure 3a and b). In relation to force, males had a mean discomfort force of 3.3 Kg (±1.2) and females 2.2 Kg (±0.7) and males had a mean pain force of 5.2 (±1.9) Kg and females 3.6 (±0.84 Kg. In relation to discomfort and pain angles, the genders did not differ (p = 0.821 and 0.849). In relation to force applied there is a statistical difference for both discomfort (p = 0.021) and pain (p = 0.023) between males and females with females perceiving discomfort with 1.1Kg less force and pain with 1.7Kg less force.

	Discomfort Reported (degrees)	Pain Reported (degrees)	Discomfort Reported (Kg Force)	Pain Reported (Kg force)
Male	89.6°(±7.2)	98° (±8.6)	3.3 (±1.2)	5.2 (±1.9)
Female	90.5°(±10.1)	98.7° (±7.6)	**2.2 (±0.7)**	*3.6 (±0.84)*

Table 2: Gender Differences in Degrees of Wrist Flexion and Force applied on Reporting Discomfort and Pain

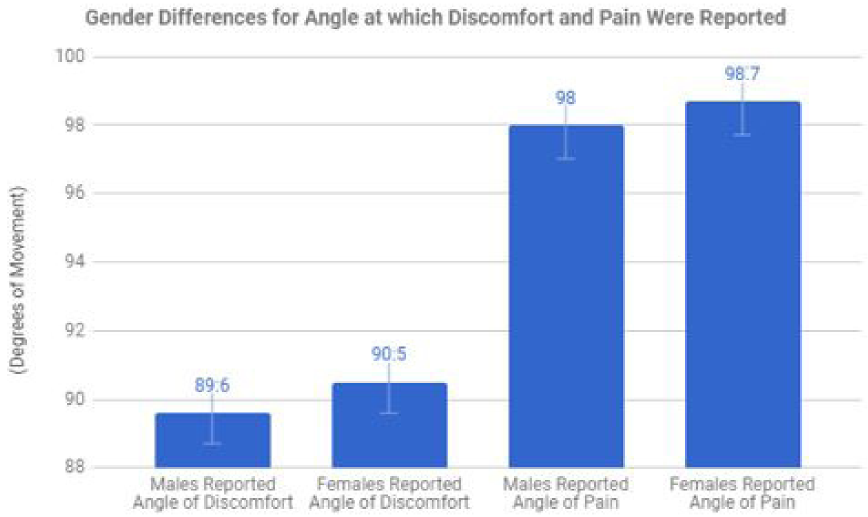

Figure 3a: Gender Differences for Angle of flexion which discomfort and pain were reported

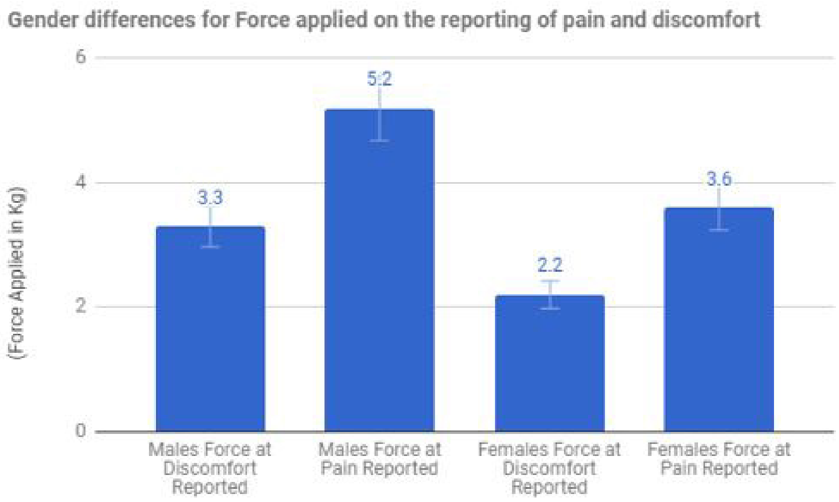

Figure 3b: Gender Differences for differences for Force applied which discomfort and pain were reported

Discussion

This experimental study was the first to quantify the ranges of movement and forces involved in the application of IWH and PITWF restraint techniques to induce discomfort and pain. The normal range of passive wrist flexion reported in young adults (18-29 years) is 93o (±8°) (Macedo and Magee, 2009) explaining the self-reporting of discomfort at 90.1° (± 8.6) and pain 98.4° (± 7.9) of wrist flexion. In this study ranges of movement between the genders were similar differing by only 1o in favour of females possessing more flexibility, a finding supported by Macedo *et al.*, (2011) who observed females possessed 1.3o greater movement across 11 peripheral joints than did males [31]. Additionally, females at the onset of puberty and through the teenage years' experience a transient increase in joint laxity (Soucie *et al.*, 2011), this knowledge should be considered in individualised restraint plans for females since the presence of hypermobility confers a greater risk of soft tissue injuries and fractures during physical activities (Díaz *et al.*, 1993, Smith *et al.*, 2005, Holick *et al.*, 2017) [32-35].

The forces required to inflict discomfort and pain were found to be small being 2.8Kg (±1.1) and 4.4Kg (± 1.8) respectively. The small load required inflicting discomfort and pain were statistically different with females experiencing discomfort with 1.1Kg less force and pain with 1.7Kg less force than males. The wrist (radiocarpal) joint is a mobile, multiaxial synovial joint relying on soft tissue structures to give it stability (Kenyon and Kenyon, 2009) [36]. WFT impose load upon dorsal soft tissues of the wrist (extensor muscles, dorsal radiocarpal ligament), and bones of the wrist joint complex, with increased load comes increased risk of discomfort, pain and/or significant injury, a concern acknowledged by the Association of Chief Police Officers (2014) [37]. Soft tissues possess viscoelastic properties, which when loaded (stressed) will elongate (strain) following a non-linear elastic pattern visualised by the stress strain curve (Robi *et al.*, 2013) but during restraint practice, it is not possible to measure the magnitude of stress or the extent of strain imposed upon the wrist [38]. It is known that loads below the point of tissue failure can result in negative structural changes and that magnitude, duration and frequency of load application negatively impact soft tissue causing irreversible plastic deformation (Wren et al., 2003, Duenwald-Kuehl *et al.*, 2012, Robi *et al.*, 2013), therefore the use of the IWH applied without pain being or any apparent injury being reported may still result in microtrauma to the wrist joint complex [38-40].

PR techniques typically fall within two categorises: non-pain inducing/non-pain compliant or pain-inducing/pain-compliant. The International Association for the Study of Pain (IASP) (2018) define pain as in individual interpretation of nociceptive signals that is unpleasant and associated with actual or potential tissue damage. Interpretation of nociceptive signals are shaped by past experiences, emotional state and mental health (Sims and Waterfield, 1997), with frequent exposure to negative nociceptive stimuli resulting in pain been more readily perceived (Ji *et al.*, 2003) [41-43]. In recognising that pain is an individual experience, those applying PR should listen to the restrained person and believe them if they report discomfort or pain, however, solely on the self-reporting of discomfort or pain to establish the limits for WFT is unreliable for the avoidance of injury since individual perceptions of pain vary and damage can occur in the absence of pain. This study was undertaken in a controlled experimental setting, with participants who were free from cognitive or communication impairments, who did not experience physiological or psychological distress, and could end the wrist flexion whenever they wanted meaning that altered perceptions of discomfort and pain that may arise during a real incident were not measured. Suggests that staff can safely limit the angle of flexion imposed and force applied during the application of WFT should be challenged particularly during a real-world PR situation where those applying PR techniques are likely to experience cognitive and motor skill impairment as a result of the stressful situation, increasing the likelihood of misapplication of techniques and increasing the of pain and/or injury (Selye, 1975; McEwen, 2000; Metz *et al.*, 2005; Metha and Parasuraman, 2014; Keller-Ross *et al.*, 2014) [44-48]. From the findings of this research, restraint techniques that involve flexed wrists (with or without force to induce pain) or other techniques which involve pain inducement where the margin for error is small, are likely to increase the risks of anatomical, physiological or psychological harm to those restrained.

Many people in settings where restraint is used which might include the use of the IWH and PITWF have a range of support needs including acute mental ill health and other psychological and physiological co-morbidities including mental impairment, intellectual disability, Asperger's and Autism, Attention Deficit Hyperactivity Disorder (ADHD), asthma, epilepsy, anxiety or depression (YJB 2014, 2015, 2016) so the adverse impact of such techniques could be more significant for such individuals [16,17,49].

Conclusion

The primary aim of this study was to investigate WFT of IWH and PITWF to understand the angles and forces involved in their application to inform safe practice so that harm to those subject to such interventions can be minimised [50-53]. The efficacy and safety of WFT should be challenged since such techniques load musculoskeletal structures in a way that can result in discomfort, pain and injury [54]. The IWH is intended to be a non-pain inducing, however in this study, the range of movement between reported discomfort and pain when the WFT was applied was only 8.4o of movement and 1.6 Kg of force. Such a small margin of error for mis-application and the potential for pain or injury challenges current practice where WFT are taught [55-60]. Organisations authorising and approving the use of WFT should be transparent and acknowledge that with WFT the margins for error are small and therefore it is likely that discomfort, pain or distress to individual's will occur during their use [61-64]. Induced pain may occur as a result of intentional application to misapplication, or as a result of staff inability to understand the individual's physical limitations and/or perception of pain, and the inability to finely control the use of WFT whilst under stress managing individuals who are struggling against their restraint [65]. The findings of this research would indicate that all WFT should be considered as pain inducing with increased risk of injury, with individual WFT only varying in the degree of pain they induce [66]. Organisations using WFT should re-consider whether such techniques are acceptable professionally and ethically and should review whether WFT should be authorised and approved for practice [67-69].

References

1. RAB [Restraint Advisory Board] (2011) Assessment of Behaviour Recognition & Physical Restraint for Children in the Secure Estate. Report to the Restraint Management Board Ministry of Justice Restraint Advisory Board Report: Assessment. London, HMSO, UK.

2. NICE (2015) Violence and aggression: short-term management in mental health, health and community settings. Guidance and guidelines.

3. National Offender Management Service (2012) Minimising and Managing Physical Restraint (MMPR), UK.

4. MIND (2013) Mental health crisis in care: physical restrain in crisis, UK.

5. Department of Health (2014) Positive and Proactive Care: Reducing the Need for Restrictive Interventions, UK.

6. Hucksorn KA (2015) Reducing seclusion and restraint use in inpatient settings: a phenomenological study of state psychiatric hospital leader and staff experiences. J Psychosoc Nurs Ment Health Serv 52: 40-7.

7. Allen D, Lowe K, Brophy S, Moor K (2009) Predictors of restrictive reactive strategy use in people with challenging behaviour. Journal of Applied Research in Intellectual Disabilities 22: 159-68.

8. Tenneij NH, Koot HM (2008) incidence, types and characteristics of aggressive behaviour in treatment facilities for adults with mild intellectual disabilities and severe challenging behaviour. J Intellect Disabil Res 52: 114-24.

9. Heyvaert M, Saenen L, Maes B, Onghena P (2014) Systematic review of restraint interventions for challenging behaviour among persons with intellectual disabilities: focus on experiences J Appl Res Intellect Disabil 27: 493-510.

10. Hawkins, S, Allen D, Jenkins R (2005) The use of physical interventions with people with intellectual disabilities and challenging behaviour: the experiences of service users and staff members. Journal of Applied Research in Intellectual Disabilities 18: 19-34.

11. Smallridge P, Williamson A (2011) Report on implementing the Independent Review of Restraint in Juvenile Secure Settings, UK.

12. Department of Health (2012) Transforming Care: A national response to Winterbourne View Hospital, UK.

13. MIND (2015) Restrain in Mental Health Services. What the guidance says, UK.

14. Heyvaert M, Saenen, L, Maes B, Onghenga P (2014) Systematic review of restraint interventions for challenging behaviours among persons with intellectual disabilities: focus on effectiveness on single-case experiments. J Appl Res Intellect Disabil 27: 493-510.

15. Youth Justice Board (2014) Statistical Notice. Minimising and Managing Physical Restraint (MMPR) Data Collection, UK.

16. Youth Justice Board (2015) Statistical Notice. Minimising and Managing Physical Restraint (MMPR) Data Collection, UK.

17. Youth Justice Statistics (2016) 2014/15 England and Wales Youth Justice Board / Ministry of Justice Statistics bulletin, UK.

18. Campbell D (2018) Figures reveal 'alarming' rise in injuries at mental health units. Questions are being raised over the effectiveness of the governments drive to cut use of restraint, UK.

19. Muir-Cochrane E, Oster C, Grotto J, Gerace A, Jones J (2013) The inpatient psychiatric unit as both a safe and unsafe place: Implications for absconding. Int J Ment Health Nurs 22: 304-12.

20. Farina-Lopez E, Estevez-Cuerra GJ, Gandoy-Crego M, Polo-Luque LM, Gomez-Cantorna C, et al. (2014) Perception of Spanish nursing staff on the use of physical restraints. J Nurs Scholarsh 46: 322-30.

21. Wilson C, Rouse LO, Rae S, Kar Manan R (2017) Is restraint 'a necessary evil' in mental health care? Mental health inpatients and staff members experiences of physical restraint. Int J Ment Health Nurs 26: 500-12.

22. Department of Health and Human Services (2006) Office of Inspector General: Hospital reporting of deaths related to restraint and seclusion 2006: OEI-09-04-00350.

23. Care Quality Commission (2011) Count me in 2010. Care Quality Commission and National Mental Health Development Unit, UK.

24. Duxbury J, Aiken F, Dale C (2011) Deaths in custody: The role of restraint. Journal of Learning Disabilities and Offending Behaviour 2: 178-89.

25. Barnett R, Stirling C, Pandyan A (2012) A review of the scientific literature related to the adverse impact of physical restraint: gaining a clearer understanding of the physiological factors involved in cases of restraint-related death. Med Sci Law 52: 137-42.

26. Patterson B (2005) Thinking the unthinkable: a role for pain compliance and mechanical restraint in the management of violence? Mental Health Practice 8: 18-23.

27. Strubbs B, Hollins L (2011) Are physical intervention techniques likely to cause pain or injury when applied to manage the severely aggressive older adult? A survey of physiotherapist's expert views in the UK. J Clin Nurs 20: 2666 -75.

28. Her Majesty's Inspectorate of Prison Services (2015) Behaviour Management and Restraint of Children in Custody, UK.

29. Her Majesty's Inspectorate of Prison Services (2017) Children in Custody 2016-17 An Analysis of 12-18 Year Olds' Perceptions of Their Experiences in Secure Training Centres and Young Offender Institutions, UK.

30. Biometrics Ltd (2017) BiometricsDataLOG, UK.

31. Macedo L, Magee DJ (2009) Effects of Age on Passive Range of Motion of Selected Peripheral Joints in Healthy Adult Females. Physiother Theory Pract 25: 145-64.

32. Soucie JM, Wang C, Forsyth A, Funk S, DennyM, et al. (2011) Range of motion measurements: reference values and database for comparison studies. Haemophilia 17: 500-7.

33. Díaz MA, Estévez E, C Guijo PS (1993) Joint Hyperlaxity and Musculoligamentous Lesions: Study of a Population of Homogenous Age, Sex and Physical Exertion. Br J Rheumatol 32: 120-2.

34. Smith R, Damodaran AK, Swaminathan S, Campbell R, Barnsley L (2005) Hypermobility and Sports Injuries in Junior Netball Players. Br J Sports Med 39: 628-31.

35. Holick MF, Hossein-Nezhad A, Tabatabaei F (2017) Multiple Fractures in Infants who have Ehlers-Danlos/Hypermobility Syndrome and or Vitamin D Deficiency: A Case Series of 72 Infants Whose Parents Were Accused of Child Abuse and Neglect. Dermatoendocrinol 9: e1279768.

36. Kenyon K, Kenyon J (2009) The Physiotherapist's Pocketbook (2nd Edn) UK.

37. Association of Chief Police Officers (2014) Personal Safety Manual. London: National Policing Improvement Agency, UK.

38. Robi K, Jakob N, Matevz K, Matjaz V (2013) The Physiology of Sports Injuries and Repair Processes. Current Issues in Sports and Exercise Medicine 2013: doi: 10.5772/54234.

39. Wren TAL, Lindsey DP, Beaupré GS, Carter DR (2003) Effects of Creep and Cyclical Loading on the Mechanical Properties and Failure of Human Achilles Tendons. Ann Biomed Eng 31: 710-7.

40. Duenwald-Kuehl S, Kondratko J, Lakes RS, Vanderby Jr R (2012) Damage Mechanics of Porcine Flexor Tendon: Mechanical Evaluation and Modelling. Ann Biomed Eng 40: 1692-707.

41. International Association for the Study of Pain (2018), UK.

42. Sims J, Waterfield J (1997) Validity, Reliability and Responsiveness in the Assessment of Pain. Physiotherapy Theory and Practice. 13: 23-37.

43. Ji RR, Kohno T, Moore KA, Woolf CJ (2003) Central Sensitization and LTP: Do Pain and Memory Share Similar Mechanisms? Trends Neurosci 26: 641-706.

44. Selye H (1975) Implications of stress concept. New York State Medical Journal 75: 2139-45.

45. McEwen BS (2000) Effects of adverse experiences for brain structure and function. Biol Psychiatry 48: 721-31.

46. Metz GA, Jadavji NM, Smith LK (2005) Modulation of function by stress: a novel concept of the effects of stress and corticosterone on behaviour. Eur J Neurosci 22: 1190-200.

47. Mehta RK, Parasuraman R (2014) Effects of Mental Fatigue on the Development of Physical Fatigue: A Neuroergonomic Approach. Human Factors. Hum Factors 56: 645-56.

48. Keller-Ross ML, Pereira HM, Pruse J, Yoon T, Schlinder-DeLap B, et al. (2014) Stressor-induced increase in muscle fatigability of young men and women is predicted by strength but not voluntary activation. J Appl Physiol 116: 767-78.

49. Youth Justice Board (2014) Statistical Notice Minimising and Managing Physical Restraint (MMPR) Data Collection, UK.

50. American Academy of Paediatrics (2001) The Assessment and Management of Acute Pain in Infants, Children and Adolescents. Paediatrics 108: 793-7.

51. Care Quality Commission (2015) Brief Guide: Restraint (Physical and Mechanical), UK.

52. Cole TJ, Rousham EK, Hawley NL, Cameron N, Norris SA, et al. (2015) Ethnic and Sex Differences in Skeletal Maturation Among the Birth to Twenty Cohort in South Africa. Arch Dis Child 100: 138-43.

53. Fischer AA (1987) Pressure algometry over normal muscles. Standard values, validity and reproducibility of pressure threshold. Pain 30: 115-26.

54. Gerace A, Oster C, O'Kane D, Hayman CL, Muir-Cochrane E (2016) Empathic processes during nurse-consumer conflict situations in psychiatric inpatient units: A qualitative study. Int J Ment Health Nurs 27: 92-105.

55. Ghasemi A, Zahediasl S (2012) Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. International Int J Endocrinol Metab 10: 486-9.

56. Gooch K (2015) Who Needs Restraining? Re-examining the Use of Physical Restraint in an English Young Offenders Institution. Journal of Social Welfare and Family Law 37: 3-20.

57. Hicks CM (2009) Research methods for Clinical Therapists. Applied Project Design and Analysis (5th Edn) UK.

58. International Association of Athletics Federations (2012) Soft Tissue Damage and Healing: Theory and Techniques. Monte Carlo: International Association of Athletics Federatio, USAn.

59. IBM Corp (2016) Statistical Package for the Social Sciences.

60. Keski-Valkama A, Sailas E, Eronen M, Koivisto AM, Lönnqvist J, et al. (2009) Who are the restrained and secluded patients: A 15-year nationwide study. Soc Psychiatry Psychiatr Epidemiol 45: 1087-93.

61. Middleton C (2006) Epidural Analgesia in Acute Pain Managemen, UK.

62. Millan MJ (1999) The Induction of Pain: An Integrative Review. Prog Neurobiol 57: 1-164.

63. Murray KJ (2006) Hypermobility disorders in children and adolescents. Best Practice & Clinical Rheumatology 20: 329-51.

64. National Offender Management Service (2014) Home Office Manual for Escorting Safely Techniques, UK.

65. Norkin CC, White NJ (2016) Measurement of Joint Motion: A Guide to Goniometry (5th Edn) USA.

66. Rikken-Bultman DG, Wellink L, van-Dongen PWJ (1997) Hypermobility in two Dutch School Populations. Eur J Obstet Gynecol Reprod Biol 73: 189-92.

67. Steele VA, White JA (1986) Injury Prediction in Female Gymnasts. Br J Sports Med 20: 31-3.

68. Tortora GJ, Derrickson B (2011) Principles of Anatomy and Physiology: Organization, Support and Movement, and Control Systems of the Human Body (13th Edn) USA.

69. Winship G (2006) Further thoughts on the process of restraint. J Psychiatr Ment Health Nurs 13: 55-60.