THE POINT PREVALENCE OF INJURIES IN RETIRED COMPETITIVE FEMALE GYMNASTS

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Abstract **Word count:** 193

A sample of 120 retired competitive female gymnasts were administered a questionnaire, with a response rate of 30.8% (n=37). The questionnaire collected information detailing the number, location and type of current injuries. Information was also attained as to whether the injury was originally caused by a gymnastic-related injury and whether the injury was having an effect on the gymnasts' current lifestyle.

The total sample reported 53 current injuries or complaints, a rate of approximately 2 injuries per retired gymnast. Of the total injuries, injuries to the lower back were most common (34%), followed by ankle and foot (24.5%) and knees (17%). The most common types of injuries were sprains (30.2%) and aches or soreness (18.9%). Of the total injuries or complaints, 88.1% were originally caused by a gymnastic-related sports injury. All participants who were experiencing a current injury or complaint reported some effect on their current life.

This highlights the substantial number of injuries or complaints in the retired gymnastic population and that retired gymnasts are experiencing residual pain and interference to their daily lifestyles from injuries. These findings suggest a need to evaluate injury prevention and rehabilitation programs designed for competitive gymnasts.

The point prevalence of injuries in retired competitive female gymnasts

Introduction

Gymnastics has enjoyed a worldwide rise in popularity over the past 20 years. For example, there are currently more than 3,000,000 participants governed by USA Gymnastics[1], and around 80,000 gymnasts in excess of 600 private clubs registered with Gymnastics Australia[2]. Performed at a competitive level, Women's Artistic Gymnastics is a demanding sport both physically and mentally. The competitors need to possess strength, flexibility, agility and endurance, and the athlete must co-ordinate these skills in order to achieve difficult body movements with the varying apparatus elements.

Due to the physical nature of gymnastics, it has one of the highest injury rates in women's sport[3]. In addition, increasing numbers of children are entering the sport at a younger age[4 5], exposing an increasing number of gymnasts, for a longer period of time to potential injury. Also, the gymnastic training year is markedly longer than the season of other sports, with competitive gymnasts training for up to 11 months of the year[1]. Simply, gymnasts spend a large amount of time training per year, which apart from the obvious risk of hazardous maneuvers exposes the gymnast to a more subtle temporal risk in that increased time causes an increased risk of injury[3].

The definition of what constitutes an injury has varied greatly in previous studies researching the epidemiology of gymnastic injuries, resulting in differing injury rates

between the studies. For example, Snook[6] only considered injuries that were brought to the attention of a doctor and produced disability, which could result in fewer minor injuries being reported. For the purposes of the present study an injury or complaint was defined as any bodily pain or any condition that resulted in the disruption or limitation of daily activities, in order to include the more minor injuries that have been excluded in previous studies.

The classification of injuries reported in previous studies in this area has fallen into two main categories - acute traumatic (injury of sudden onset) and chronic overuse (injury of gradual onset)[5 7 8]. In the study by Caine[4], the researchers reported that of the injuries sustained during a one-year period, 32.7% of the injuries were re-injuries and of these 83.3% were of the chronic overuse type. This discrepancy between injury types may indicate that some gymnasts prematurely return to gymnastic activity following an injury, which may, in turn, lead to the reoccurrence of injury and contribute to chronicity.

A competitive gymnast is considered to be any gymnast that participates in competitions with a gymnastics team. Many gymnasts at a competitive level spend some part of the year training at less then full intensity as a result of injury rather than totally abstaining from practice, indicating that some injuries do not receive adequate rehabilitation[4 5 6]. Singer[9] has previously cautioned that returning to training without 100% recovery following an injury could result in retirement of the gymnast.

Several studies involving the epidemiology of gymnastic injuries have only been carried out during the gymnasts' career, asking the question, "What is the nature and rate of injuries that affect young competitive female gymnasts[3 4 5]?" Though these studies have determined areas of special consideration with regards to specific injuries and specific maneuvers, research also needs to assess the long-term repercussions of the injuries sustained during intensive gymnastic training on the gymnasts' future lifestyles. Do gymnastic injuries continue to affect gymnasts even in retirement? Determining the answer to this question will hopefully aid in the development and progression of injury prevention and rehabilitation programs designed for gymnastics.

This study aimed to determine the prevalence and functional effects of musculo-skeletal injuries in retired competitive female gymnasts. The project also aimed to determine whether there was a higher incidence of injuries or complaints experienced in retired gymnast's lifestyles compared with the general Australian adult population[10].

Method

Subject Selection:

One hundred and twenty (n=120) retired competitive female gymnasts were administered a questionnaire via mail. All participants were asked via a cover note to complete and return the questionnaire to the researchers if they were willing to participate in the study.

Questionnaires were anonymous. Returning a completed questionnaire implied consent to participate in the study.

Design:

The questionnaire used in this study was a compilation of questions used in previous studies, notably the studies conducted by Kolt and Kirkby[5] on the epidemiology of injuries in Australian female gymnasts, and the survey carried out by Walker[11] on Low Back Pain in Australian adults. The questionnaire requested information on participant demographics (age, height, weight), training profile (hourly rate they trained per week, number of years they trained), and a current injury or complaint profile (any current injuries, pain, discomfort or limitations).

The questionnaire mostly obtained current facts and information. However, it also asked questions of a retrospective nature, to ascertain the amount of training completed, and whether the present injuries or complaints were originally incurred during the participants' gymnastic career.

Ethics approval was required prior to conducting the research. Once approved, the questionnaire was sent to an expert in epidemiology to receive feedback on the quality of the questionnaire. After making amendments in response to the expert's comments, a pilot test was conducted. The sample consisted of five candidates who trialed the questionnaire and provided test results. This piloting procedure confirmed the face

validity of the questionnaire because each of the five pilot study participants answered the questions the way they were intended to be answered.

Statistical Analysis:

The data were analysed using descriptive statistics, t-tests, Pearson's r correlations and a between groups ANOVA. Data are presented as frequency tables, means, standard deviations, percentages and correlations.

Results

The return rate of the questionnaire was 30.8% (n=37). The respondents were 37 retired competitive female gymnasts between the ages of 18 and 26 years (M = 20 years, SD = 2.1). The sample included one former junior elite gymnast, who had trained for 5 days, 40 hours per week. The remaining gymnasts were National stream gymnasts ranging from levels 6 through to 10 (M = level 8, SD = 0.8). National stream gymnasts had trained for between 2-6 days per week (M = 4.3 days, SD = 0.9), and 6-28 hours per week (M = 16.4 hours, SD = 6.1). The gymnasts had trained for between 5 to 13 years (M = 9.3 years, SD = 2.4) and been retired for 1 to 10 years (M = 3.8 years, SD = 2.1). The competition level of the gymnasts ranged from club championships to international competition.

The current average weight of the participants was 55.1kg (range = 42-75kg, SD = 6.3) and the average height was 163.3cm (range = 152-176cm, SD = 6.3).

The total sample (n=37) reported 53 current injuries or complaints (a rate of approximately 2 injuries per person). Figure 1 displays the prevalence of injuries reported by the participants, which shows 70.3% (n=26) of respondents having at least one current injury or complaint. Of the injuries or complaints reported, 69.8% (n=37) were originally caused by a gymnastic-related sports injury, as shown in Table 1. However, upon removal of the 20.8% (n=11) of gymnasts who did not specify the cause of the injury or complaint, the percentage of gymnastic-related injuries rises to 88.1%.

Insert Figure 1 about here

Insert Table 1 about here

Table 2 indicates that the most common area of complaint was the lower back (34%, n=18), of which majority (88.9%) were originally caused by a gymnastic-related injury. A further 49.1% of the total injuries occurred in the lower limb as a whole (n=26), with the ankles (24.5%) and knees (17%) being most commonly affected.

Insert Table 2 about here

Table 3 indicates that of the total injuries reported, the most common type of injury was a sprain (30.2%) followed by an ache or soreness (18.9%). Of the total injuries, 64.1% were of the acute traumatic type (n=34), 17% were of the chronic overuse type (n=9), and 18.9% were simply described as an ache (n=10). A total of 85.3% (n=29) of the acute traumatic injuries and 77.8% (n=7) of the chronic overuse injuries in the retired gymnasts originally occurred during the gymnasts' career.

Insert Table 3 about here

Over half of the participants (54.7%) used physiotherapy as the form of treatment for their injuries, followed by rest (18.9%) and no treatment (17%) (Table 4). Around a third (35.9%) reported their pain as constant, while 56.6% (n=30) experienced intermittent pain, mostly exacerbated by certain movements or activities.

Insert Table 4 about here

All participants who were experiencing a current injury or complaint (n=26) reported having some effect on their current life. Of the total injuries reported, 62.3% were found to be causing the retired gymnast pain or interfering with their current lives. The average pain at the present time (at the time the questionnaire was completed) was 2.9 (SD = 2.4), where 0 is no pain and 10 is the worst imaginable pain. In the month immediately prior

to completion of the questionnaire, the average value for the participants' worst pain was 5.5 (SD = 2.6) and their usual pain was 3.5 (SD = 2.2).

The participants reported between 0 to 14 days in the past month where they were kept from their usual activities (work, school or recreation) due to pain (M = 1.7, SD = 2.9). In the previous month, the pain from participants' injuries interfered with their daily activities with an average rating of 2.7 (SD = 2.3), where 0 is no interference and 10 is unable to carry on activities. They also reported an average change of 2.6 (SD = 2.2) for their ability to take part in recreational or social activities and 2 (SD = 1.6) for their ability to work (including work in and around the house), where 0 is no change and 10 is extreme change.

There were very small, non-significant, correlations between the number of injuries incurred by each gymnast and the length of years spent training (p=0.589), competition level (between groups, p= 0.544), training level (p=0.568) of the gymnast, and gymnasts' ages (p=0.443). Similarly, there was little correlation between the number of days or hours trained per week and the number of injuries experienced by the retired gymnasts.

Insert Table 5 about here

There was no significant difference between the amount of pain experienced by the participant (present, usual or worst pain) based on the type of injury (acute traumatic or chronic overuse), or between the interference to recreational, social and work activities

with the type of injury. However, chronic overuse injuries were found to cause significantly higher interference to the participants' ability to carry out activities of daily living ($p = 0.035$) compared to acute traumatic injury onset.

Discussion

Gymnastics, with its hazardous maneuvers and intensive training, produces one of the highest injury rates in sport[3-5]. What has not been proven is the long-term functional effect of these injuries and the history of intensive training on the gymnasts' future lifestyles. The current research aimed to determine the prevalence and functional effects of musculo-skeletal injuries in retired competitive female gymnasts, and whether this incidence is higher compared with the Australian adult population[10].

It was found that 70.3% of respondents reported suffering from a present injury or complaint, with half of these experiencing two or more injuries. This highlights the substantial number of injuries or complaints in the retired gymnastic population.

Of the present musculo-skeletal injuries or complaints reported by the retired female gymnasts, 88.1% were originally caused by a gymnastic-related sports injury. Comparing this figure with data from the National Health Survey[10] on injuries, around 24% of all musculo-skeletal conditions were originally the result of an injury. This suggests that gymnasts are sustaining injuries during their career that are not resolving, be that due to inadequate rehabilitation, premature return to activity following an injury

and/or the recurrence of the same injury. All these factors contribute to the chronicity of injuries, which may result in the higher number of complaints seen in the retired gymnast population compared with the general Australian population.

All participants who were experiencing a current injury or complaint reported having some effect on their current life from an injury. Further, 62.3% of the reported injuries were found to be having a detrimental effect on the gymnasts' current lifestyle. This figure could have been higher as some gymnasts reported that the only thing that aggravated their pain was playing particular sports or partaking in particular activities, which they had not done in the past month. This suggests that the short testing period of one month may have overlooked some of the results, and future research needs to record data over a longer period of time. However, this result still demonstrates that injuries incurred during the gymnasts' career are causing the retired gymnast pain. Of even greater concern is that this pain is interfering with their ability to take part in daily, social, recreational and work activities.

Of the injuries described, 64.1% were originally of the acute traumatic type, 17% were of the chronic overuse type, and 18.9% were simply described as an ache. In previous research by Kolt and Kirkby, [5 12] acute injuries dominated the results in both elite and subelite gymnasts. However, of the 34 acute injuries reported in this current study, 29 (85.3%) originally occurred during the gymnasts' career. This suggests that either the injury never resolved and became a chronic injury or that the participant has re-injured

the area. Regardless, the fact remains that the original damage was done during training, predisposing the gymnasts to future pain and discomfort.

Chronic overuse injuries were found to cause a significantly higher change in the gymnasts' ability to partake in activities of daily living ($p=0.035$). Of the chronic injuries, the majority (77.8%) originated during the gymnasts' career. This substantiates the thought that chronic overuse injuries sustained throughout the gymnasts' career do not resolve. This is possibly due to incomplete recovery and premature return to gymnastic activity following an injury. Premature return to activity may lead to the reoccurrence of chronic injuries and therefore continue to present as a residual complaint in gymnasts' future (non-gymnastic) lives[4]. Therefore, it is important to allow adequate recovery and strengthening of injuries, particularly of the chronic overuse type, in order to achieve complete resolution of the original injury.

The most frequent type of injury was the sprain, occupying 30.2% of the reported injuries. This value is consistent with numerous studies reporting injury epidemiology in gymnastics[5 12 13]. However, as opposed to those results, the present result is reported in retired gymnasts who sustained the sprain whilst training and are still experiencing discomfort from the injury some years later. Conversely, it is regarded that previous injury is a risk factor for subsequent injury at the same site[4 14], so any person who has experienced a sprain is at risk of re-injury and this risk is greater if the joint is continually placed under stress. Therefore, gymnasts who experience a sprain during their career are more likely to re-injure the area, resulting in residual discomfort in their future lifestyles.

In accordance with other studies[4 8 12], the lower limb as a whole recorded the highest number of injuries, with just under half of all current injuries (49%). 50% of the injuries in the lower limb occurred at the ankle and foot. Pettrone and Ricciardelli[13] found that the floor exercise (tumbling) had the highest number of injuries (35%) followed by beam, then vault. These authors stated that a large proportion of injuries occurred at the mount or dismount possibly due to rewarding high-risk maneuvers in the gymnastic scoring system. Similarly, Caine et al[4] reported 35.7% of the sprains occurred during the dismount. This highlights the point that there is increased risk of injury from difficult and hazardous mounts, dismounts, and tumbling while gymnasts are training and that a large number of injuries occur during these movements in the lower limb. As seen in this present study, lower limb injuries seem to have more residual effects in retired gymnasts than other body parts. This would be expected, as weight-bearing limbs require longer rehabilitation than non-weight bearing limbs. However, there may also be unresolved tissue damage from landing injuries that predisposes the area to subsequent injury[4 14]. Injury prevention and rehabilitation programs already place focus around these areas of the sport, however due to the dangerous nature of the maneuvers and unpredictability of the gymnast, a high number of injuries continue to occur in these areas. Therefore it is imperative that performing maneuvers such as mounts, dismounts and tumbling should be limited to short periods of time, whereby the gymnast can exercise their full concentration and strength whilst performing the dangerous maneuvers.

The lower back was found to be the single most commonly injured area in retired gymnasts registering 34% of the complaints, of which the majority (88.9%) were originally caused by a gymnastic-related injury. This brings attention to the nature of the maneuvers conducted in gymnastics, requiring gymnasts to hyperextend their lower back, placing it under a great deal of stress and predisposing the area to lingering pain or discomfort. This finding is consistent with the research conducted by Caine et al.[4] who found the highest number of injuries in gymnasts occurred in the lower back (18.3%).

The same study[4] also suggested that of the injuries reported during a one-year period, 32.7% were re-injuries. Of the injuries to the lower back, there was a 72.2% rate of re-injury. This suggests that once injured, the lower back is prone to re-injury and is likely to remain a problem throughout the gymnasts' life, which was shown in this present study as just under half (48.6%) of the retired gymnasts reported having a lower back complaint. Thus, the solution would be to reduce the incidence of lower back injuries initially, in order to then reduce the incidence seen in retired gymnasts' current lifestyles. Preemptively introducing segmental stabilisation exercises for the lower back to gymnasts prior to reaching a competitive level may help reduce the risk of injuring the lower back. Although many muscles of the trunk are capable of contributing to the protection and stabilisation of the lumbar spine, recent evidence suggests that transverse abdominis (TA) and multifidis play a significant role in the reduction of lower back pain[15]. The exercises include activating an isometric co-contraction of the TA and multifidis muscles and training the patient to hold a low level tonic contraction[15].

Surprisingly, results from this present study suggest that the intensity of the training has no impact on the risk of experiencing residual pain from a gymnastic-related injury, as there was no correlation between the training or competition level of the gymnast and the number of injuries seen in the retired gymnasts. Research from Lowry and Leveau[16] determined that competitive gymnasts were at a higher risk of injury than non-competitive gymnasts. This previous result is consistent with the results of this study as all participants were at a competitive level while they were training, which suggests that any injury sustained once the gymnast reaches a competitive level has an equal risk of affecting the gymnasts later in life. The present study also found no correlation between the number of injuries and the age of the participant, the number of hours per week or years spent training. This result demonstrates that the length of time spent participating in the sport does not increase the risk of incurring an injury that will continue to have an effect on the gymnasts' future lifestyle. Conversely, previous research[4 5 13] has found that the longer the duration and the higher the intensity of the workout, the greater the risk of injury for the gymnast. For example, in the study by Kolt and Kirkby[12], elite gymnasts had a higher injury rate than subelite gymnasts. However, this present result regarding the number of injuries in retired gymnasts is not determined by the duration or intensity of the workout, but by the severity of the original injury, the time allowed for recovery and the subsequent rehabilitation of the injury. Therefore, future research needs to assess the recovery and rehabilitation of gymnastic injuries at their original onset to then be able to evaluate the risk of injuries in retired gymnasts.

Conclusion

Gymnastics is a popular and thoroughly enjoyable sport. However, the results of this study highlight that retired gymnasts are experiencing residual pain and interference to their daily lifestyles from injuries that obviously have not resolved from their original onset. Also, the results of this study on injury location and type are remarkably similar to epidemiology studies carried out during the gymnasts' career, suggesting that injuries are carried into retirement. This implies a need to improve injury prevention and rehabilitation programs designed for gymnasts and a need for further education into the rehabilitation of injuries for both coaches and gymnasts at any competitive level. However, due to the hazardous and unpredictable nature of gymnastics, injuries will continue to occur. For that reason, providing adequate recovery time and correct strengthening of the injury will hopefully decrease the deleterious long-term effects reported in this study by retired gymnasts.

Acknowledgements

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APPENDIX 1 – TABLES AND FIGURES

Figure 1. Injury frequency per gymnast

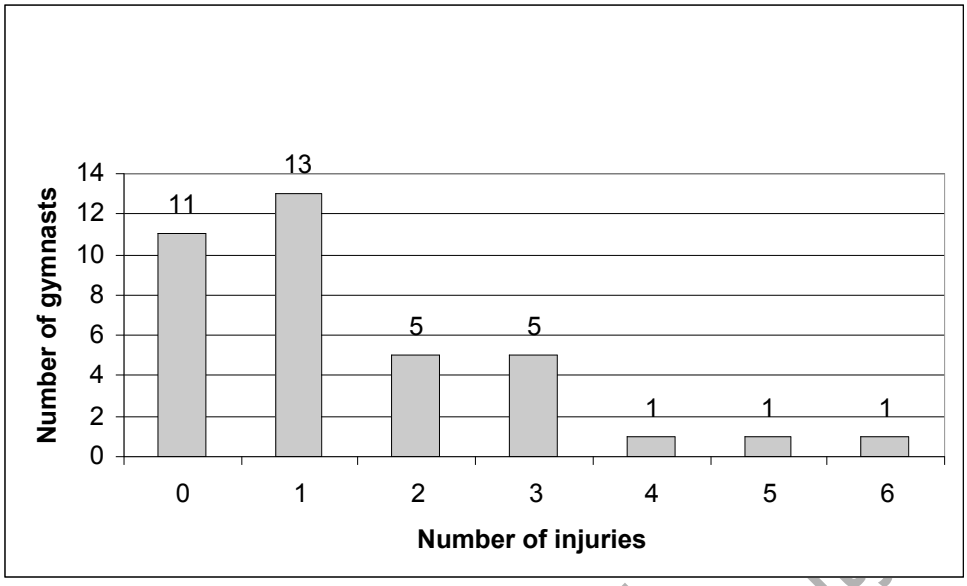

Table 1. Cause of injuries

	Number of injuries	
	Overall Sample (n=53)	
Cause of injury	*n*	*%*
Gymnastic-related	37	69.8
Other	5	9.4
Unspecified	11	20.8

Table 2. Injury location

	Number of injuries	
	Overall Sample (n=53)	
Location of injury	*N*	*%*
Low back	18	34
Ankle and foot	13	24.5
Knee	9	17
Neck	4	7.6
Wrist and hand	3	5.7
Elbow	2	3.8
Hip	2	3.8
Lower leg	2	3.8

Table 3. Injury type

	Number of injuries	
	Overall Sample (n=53)	
Type of injury	*n*	*%*
Sprain	16	30.2
Ache/Soreness	10	18.9
Strain	6	11.3
Tear (ligament)	4	7.6
Stress fracture	4	7.6
Dislocation	3	5.7
Osgood-Schlatter's disease	2	3.8
Fracture	2	3.8
Spondylolysis	1	1.9
Spondylolisthesis*	1	1.9
Disc herniation	1	1.9
Tear (meniscus)	1	1.9
Perthe's disease	1	1.9
Tendonitis	1	1.9

* Spondylolytic form

Table 4. Injury treatment

	Number of injuries	
	Overall Sample (n=53)	
Type of treatment	*n*	*%*
Physiotherapy	29	54.7
Rest	10	18.9
Nothing	9	17
Chiropractic	6	11.3
Taping	4	7.6
Surgery	3	5.7
Sports physician	2	3.8
Strengthening exercises	2	3.8
Massage	2	3.8
Acupuncture	1	1.9
Bracing	1	1.9
Pain medication	1	1.9
Osteopathy	1	1.9
Plaster casting	1	1.9

Table 5. Correlations for injury frequency

	Number of injuries	
Correlation	*Pearson's r*	*Sig. (2-tailed)*
Length of years training	-0.092	0.589
Training level	-0.097	0.568
Age of participant	0.13	0.443
Days trained per week	-0.048	0.777
Hours trained per week	-0.018	0.914

APPENDIX 2 – ETHICS APPROVAL

Faculty Human Research Ethics Committee

MEMORANDUM

TO:

Principal Investigators
HSc

FROM: Assoc Prof Tony Kruger
Chair
Human Research Ethics Committee
Faculty of Human Development

DATE: June 27, 2006

SUBJECT: **Approval of application involving human subjects**

Thank you for your submission detailing amendments to the research protocol for the project titled, **The Point Prevalence of Injuries in retired competitive female Gymnasts** (HRETH.FHD.114/03).

The proposed amendments have been accepted by the Faculty Human Research Ethics Committee and approval for application HRETH.FHD.114/03 has been granted from 2/6/04 to 30/12/04

Please note that, the Faculty Human Research Ethics Committee must be informed of the following: any changes to the approved research protocol, project timelines, any serious or unexpected adverse effects on participants, and unforeseen events that may effect continued ethical acceptability of the project. In these unlikely events, researchers must immediately cease all data collection until the Committee has approved the changes.

If you have any queries, please do not hesitate to contact me on 9747 7486.

The Committee wishes you all the best for the conduct of the project.

Assoc Prof Tony Kruger
Chair
Human Research Ethics Committee
Faculty of Human Development