Research Project: Written assignment

What is the relationship between injury and training load in New Zealand elite netball?

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Abstract

Objective: To investigate whether there is a relationship between training load and injury incidence in elite netball players.

Methods: Data was collected on 32 elite players from three New Zealand netball premiership teams over a single netball season. Workload was defined as the rate of perceived exertion (RPE) multiplied by the duration of the training and quantified into acute and chronic load which was used to calculate the acute:chronic ratio.

Results: 43 injuries were recorded across the 2018 season. The most common areas of injury were the ankle (27%) and knee (25%), and low severity injuries were most frequent (72%). An inverse relationship was found between injury risk and chronic load, as chronic load increases by one arbitrary unit, the odds of being injured decrease by 56.2%.

Conclusion: These findings demonstrate that increases in chronic workload are associated with a decreased risk of injury in elite netballers.

Introduction

Netball is a high-intensity, fast-paced sport that places the body under great physical demand. It requires high levels of fitness, strength and coordination to carry out movements such as jumping, landing and changes in speed and direction. In New Zealand, netball is the most popular team sport among females, with approximately 300,000 people participating annually (Netball New Zealand, 2019; Sport New Zealand, 2015). It has been well established that netball tends to have high rates of injury, particularly in the ankle, knee, and foot as a result of multiple precipitants (Coetzee, Langeveld, & Holtzhausen, 2014; Hopper, 1986; Hopper & Elliot, 1993; Hopper, Elliot & Lalor, 1995; Langeveld, Coetzee & Holtzhausen, 2012; Whatman & Reid, 2017). Firstly, females tend to be more prone to sporting injury due to differences anatomically, physiologically, and psychologically (Holschen, 2004; Hopper, 1986). Secondly, netball can cause significant stress through the lower limb, as the hard surfaces combined with frequent jumping and landing often create high impact forces (Coetzee et al., 2014; Hopper, 1986; Hopper & Elliot, 1993; Hopper et al., 1995; Langeveld et al., 2012).

A number of studies have found that ankle injuries are the most frequent, and ligaments seem to be the most commonly damaged tissue, particularly the lateral collateral ligament in the ankle (Coetzee et al., 2014; Hopper, 1986; Hopper & Elliot, 1993; Hopper et al., 1995; Langeveld, et al., 2012). Knee injuries were highlighted as being the most disabling at the acute stage, as well as having higher long term healthcare costs (Hopper, 1986; Whatman & Reid, 2017). The most common mechanisms causing these injuries were incorrect landings, falls, and over training (Hopper, 1986; Hopper & Elliot, 1993; Hopper et al., 1995; Hopper, Hopper, & Elliot, 1995). Interestingly, elite netball players seem to have higher rates of injury incidence and are often more severe (Hopper et al., 1995; Hopper, Hopper, et al., 1995). This suggests that the fast-paced nature and high training loads of elite netball may create more vulnerability to injury (Hopper, 1986).

Elite sporting codes around the world are increasingly testing the boundaries of training load and intensity in the aim of achieving perfect performances. There is a positive relationship between greater training workload and performance, and higher intensity training and performance in sports such as swimming and running (Foster, Daniels, & Yarbrough, 1977; Mujika et al., 1995; Scrimgeour, Noakes, Adams, & Myburgh, 1986; Stewart & Hopkins, 2000). However, high training loads result in an increased incidence of illness and injury (Foster, 1998; Gabbett, 2004). This creates a dilemma and potential conflict for coaches and health professionals in balancing training loads which optimize performance and do not put the athlete at increased risk of injury. This is made further complex by evidence suggesting under training may also heighten injury risk (Cross, Williams, Trewartha, Kemp, & Stokes, 2016; Dennis, Farhart, Goumas, & Orchard, 2003). In New Zealand, this balancing act is particularly important in the sport of netball as our national team consistently competes for medals at the Commonwealth games and netball world cup. Therefore, there is a need for training which allows the player to become world class while also maintaining their health. Injuries can often lead to long term consequences which may reduce participation within netball and other physical activity (Whatman & Reid, 2017). This can reduce performance, player selection, and ultimately team success. There is a need for appropriate workloads to be quantified in order to implement safe and effective training programs into our elite netball teams.

There is an emerging body of literature around the ratio of acute and chronic workload and its relationship with non-contact injury and illness incidence in sports such as rugby league, cricket and Australian football league (AFL). In collision sports, physical contact and tackles can contribute to injuries. Netball is considered a non-contact sport so it can be assumed that a large majority of injuries are contributed to by overtraining and inadequate recovery time rather than physical contact with another player. Therefore, it may be of greater importance to develop injury prediction models based on workloads to prevent injuries. Acute workload is commonly defined as the total load performed over a week whereas chronic workload is the average load performed over a 4-week rolling average. Workload can be measured through external and/or internal measurements. External load being an absolute term which expresses the sum of work completed by the athlete (e.g. total distance ran). Internal load is the perceived workload experienced by the athlete and is commonly measured through rate of perceived exertion (RPE) multiplied by duration of the work. The ratio is produced by dividing acute workload by chronic workload. The acute:chronic ratio provides an indication of whether the athletes acute workload is greater, less or equal to workloads they have previously been exposed to. In previous studies, the acute:chronic ratio can be associated with increases or decreases in relative risk of injury in the current or subsequent weeks. Hulin and colleagues (2013) looked at elite cricket fast bowlers' acute and chronic workloads, the acute:chronic ratio, and its associated injury risk. They found a low acute:chronic ratio (i.e. acute workload is less than chronic workload) was associated with an increased risk of injury and that when the acute:chronic ratio exceeded high to very high levels for either internal or external workloads, injury risk is increased significantly compared to a acute:chronic ratio of low to moderate levels. Interestingly, when acute and chronic workloads were examined in isolation to assess injury risk in the same and subsequent weeks, only high chronic external workload showed a relationship with decreasing injury risk. These results were similar in an elite rugby league and AFL (Gabbett, 2010; Hulin, Gabbett, Lawson, Caputi, & Sampson, 2015; Stares et al., 2018). Not only was it shown that the acute:chronic ratio can be useful to predict injury but that it is superior compared to interpreting injury risk with acute and chronic loads in isolation. This information is useful for clinicians as it can be used to better predict non-contact injuries so they can ultimately be avoided. To our knowledge no study has looked at the application of acute:chronic ratios and their relationship with injury in an elite netball population. Therefore, the purpose of this study is to investigate whether there is a relationship between training load and injury incidence in elite netball players.

Methods

Participants

Thirty two players from three premiership netball teams (Central Pulse: 14 players, Northern Stars: 4 players, Mainland Tactix: 14 players) participated in the study over one competitive netball season. Physiotherapists from each individual franchise collected data comprising of workload and injury information. This data was then collated together to be analysed. This data was anonymised retrospective data and therefore, did not require ethical approval for analysis.

Quantifying workloads

Workload data was collected during the 2018 premiership netball season. Workload was defined through a subjective RPE using a 10-point category ratio scale multiplied by the duration of the session. This definition is consistent with other similar studies (Gabbett, 2010; Hulin et al., 2013).

Definition of injury

Injuries were quantified by time loss, resulting in a player not being able to complete an entire training or unable to play a full match (Gabbett, 2010; Hulin et al., 2013). Injuries were defined as either 'sudden' or 'gradual' and classified using the OSICS10 prefix injury classification and severity defined by the amount of days lost.

Data analysis

3.5 Statistical Analysis

The data was organised into weekly blocks in an excel spreadsheet under the following groups, acute load, chronic load, acute to chronic workload ratio, weekly duration. This was transcribed to SPSS version 24 for specific statistical analysis. The data was initially analysed using descriptive statistics to look at the mean, range and standard deviation of the load data, and frequency analysis of the injury. This was performed across the three cohorts and on an individual athlete basis. Following the descriptive analysis and on consultation with a biostatistician a repeated measures logistic regression with exchangeable correlation matrix was performed using SAS 9.4 (www.sas.com). Analysis was performed with respect to the dependent variables of injured or not, ill or not and then injured or ill or not. Independent variables available for analysis were cohort, acute load, chronic load, and acute to chronic ratio. They were analysed for bivariate and multiple variable associations with odds ratios, and p-values reported with the level of significance set at 0.05. All independent variables were examined for the bivariate analysis, and a best subset selection process was utilised to select the best subset of statistically significant variables for the multiple variable logistic models using p-values and a relevant form of AIC model fit statistics.

Results

As shown in Table 2, of the 32 players, a total of 43 injuries were recorded. The most common areas of injury were the ankle (27%), knee (25%), and hand/finger/thumb (16%). 74% of injuries were specified as having a sudden mechanism of injury whereas 26% were related to a gradual cause. The majority of injuries were of low severity, with 72% categorised as ‘slight’, resulting in 0-1 day lost. In total, 193 days were lost secondary to injury with a mean average of 4.49 days lost per injury. As shown in Table 1, the mean weight and age of the players was 79.1kgs and 23.65 years of age respectively. However, the weights and ages of many of the players were not recorded, therefore these are not true averages. Out of the 34 players, six were defenders, nine mid-courters, and seven shooters and ten did not specify.

Table 1

Player Demographics

Variable	**N = 32 netballers**
Mean Age (years)	23.65
Mean Weight (kg)	79.1kg
Position:	
Defence	6
Mid-court	9
Shooter	7
Un-specified	10

Table 2

Injury incidence across 2018 season

Variable	**N = 32 netballers**
Total Injuries	43
OSICS10:	

Ankle	27%
Knee	25%
Hand/finger/thumb	16%
Lower leg	14%
Elbow	2%
Hip/Groin	2%
Thigh	5%
Foot/Toe	2%
Neck	2%
Lower Leg	2%
Severity of injury (Days lost):	
Slight (0-1 day)	72%
Minimal (2-3 days)	7%
Mild (4-7 days)	9%
Moderate (8-28 days)	2%

Severe (>28 days)	9%
Career ending	0%
Total days lost to injury	193 days
Mechanism of injury:	
Sudden	74%
Gradual	26%

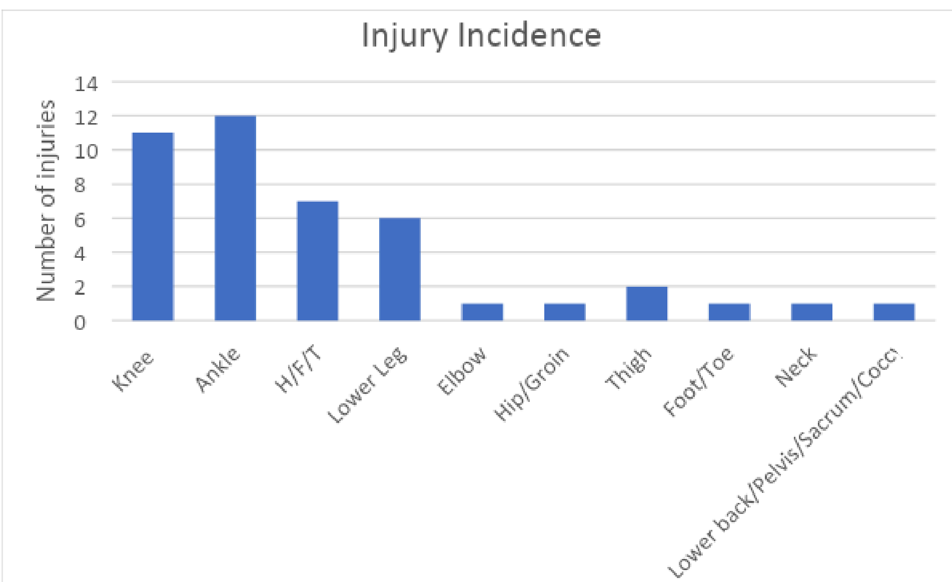

Figure 1. Total injury incidence across all teams.

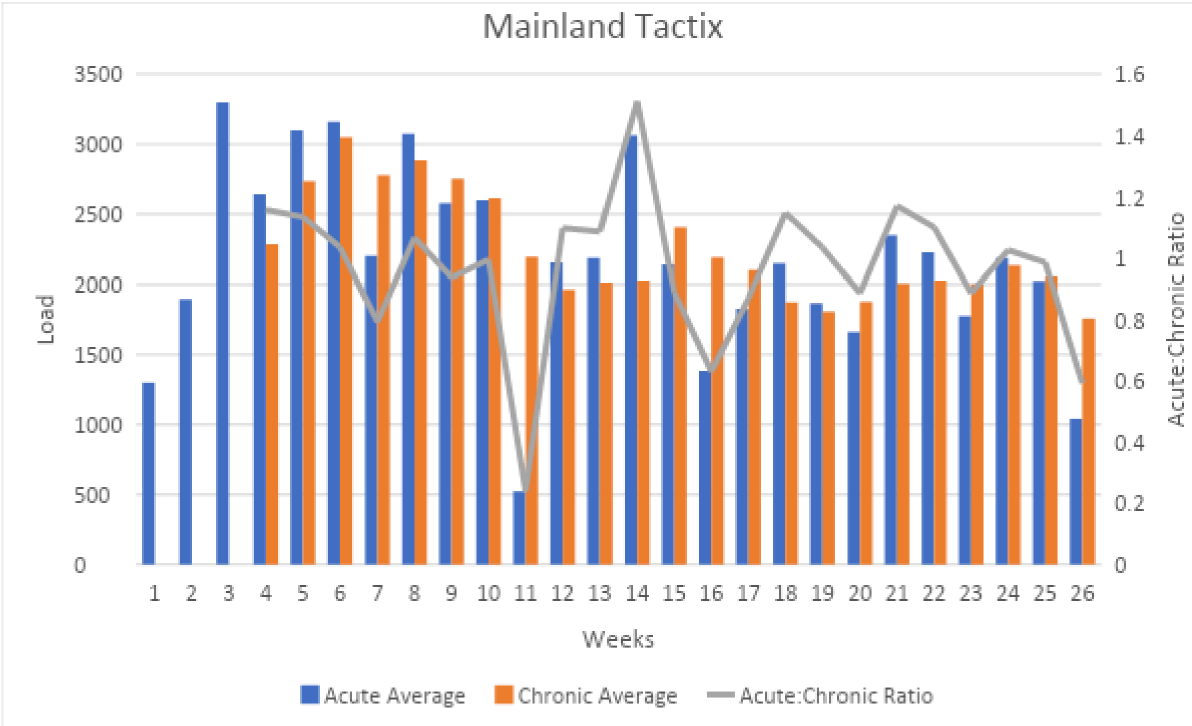

Figure 2. Average weekly load of all Mainland Tactix players.

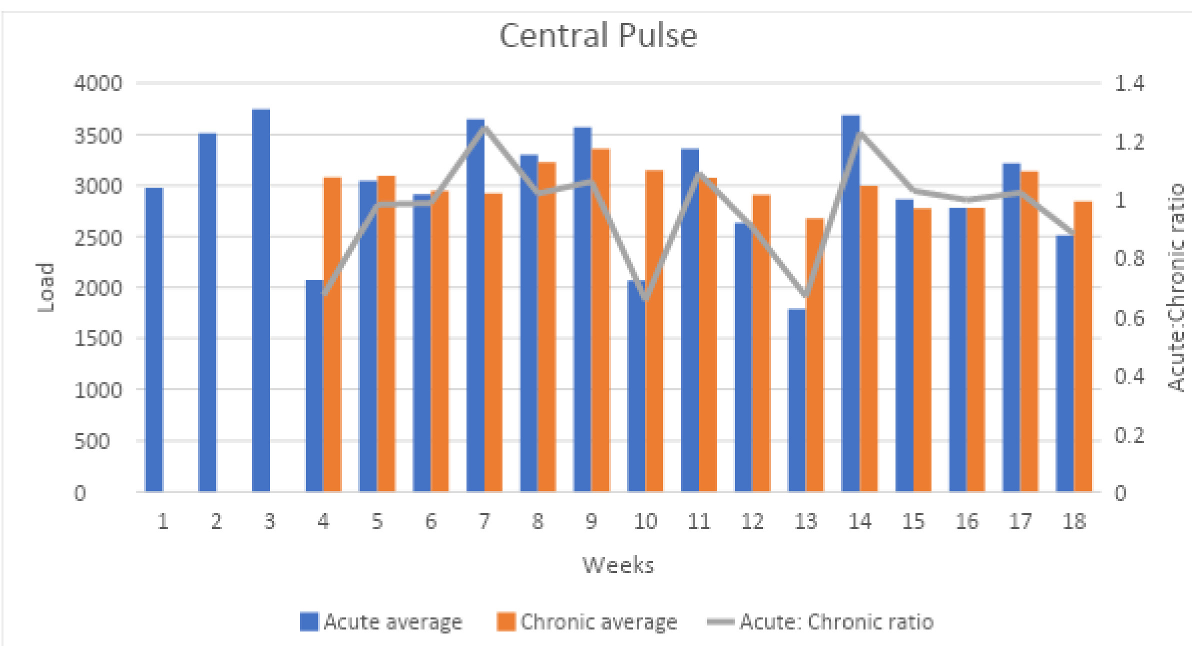

Figure 3. Average weekly load of all Central Pulse players.

Relationship between load and injury

A binary logistic regression analysis with repeated measures was undertaken. The p value was set at 0.05. The dependent variable was injury. The independent variables were acute load, chronic load and acute chronic ratio. The model included: 476 observations, 32 athletes.

Table 3

Model results

	Estimate	**Std. Error**	**z value**	**Pr(>(>|z|)**
Intercept	-2.8939	0.6325	-4.575	<0.001***
Acute load	-0.3651	0.3908	-0.934	0.3503
Chronic load	-0.8251	0.4322	-1.910	0.0561
Acute chronic	-0.1932	0.4696	-0.411	0.6808

There is a marginally significant effect of sChronicload. Since the estimate is negative, the odds ratio is exp(-0.8257) = 0.438. Since it is less than 1, this means that as sChronicload increases by 1, the odds of being injured decreases by 56.2%.

Bivariate associations

The repeated logistic regression analysis looking at the individual factors of, acute load, chronic load and acute to chronic workload ratio and relationship to injury shows that there was a marginally significant effect of chronic load on injury (p=0.056). For every 1 arbitrary unit rise in the chronic load there was a 56% decrease odds of injury.

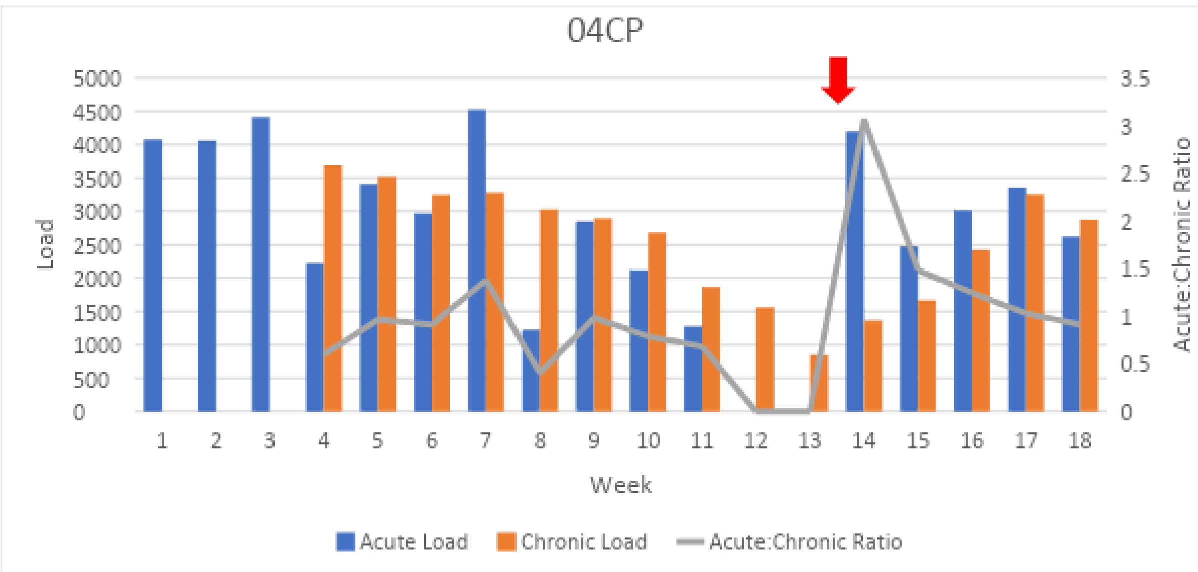

Figure 3. An example of the average weekly load for player 04CP (Red arrow indicates an injury)

Discussion

This study had relatively low rates of injury, with 43 injuries in total in this netball cohort. This means that only 11% of the season was spent with one or more players injured.

Ankle injuries occurred most frequently, contributing to 27% of total injury, followed by knee injuries at 25%. These findings align with previous studies in the area of netball injury incidence. Ankle injuries have been recognised as being the most common injury in netball (Coetzee et al., 2014; Hopper, 1986; Hopper & Elliot, 1993; Hopper et al., 1995; Langeveld et al., 2012). However, despite our findings displaying similar injury patterns to other research, the percentage of total injury appear to differ from the 58% occurrence of ankle injuries in studies by Hopper and Elliot (1993), and 84.3% in another study by Hopper et al. (1995). There are several possible factors that could influence this finding. One factor being that evidence and awareness around preventative strategies for ankle injuries has increased. Verhagen and Bay (2010) found that neuromuscular training, particularly proprioception and balance, in conjunction with external measures such as taping, shoe design, and braces are effective in preventing ankle injury.

The knee injury incidence of 25% was similar to the 22% found in Hopper and Elliot (1993), but significantly higher than Hopper et al. (1995) with 8.3%. Interestingly, in this study the percentage of ankle and knee injuries make up approximately half of the total injuries. This is significantly lower than most research in this area. Hand/finger/thumb and lower leg (16% and 14%) are other areas which made up a significant percentage of total injuries in this study.

While little literature is available on the severity of netball injuries, the findings from this study show that low severity was most common with a total of 72% of injuries resulting in 0-1 day lost. Although the mechanisms of injury were not recorded, 74% were found to be of sudden onset, and 26% gradual. In other research, the most common mechanisms of injury were incorrect landings and falls (Hopper, 1986; Hopper & Elliot, 1993; Hopper et al., 1995; Hopper, Hopper, et al., 1995). Based on this, an assumption can be made that a large proportion of the injuries sustained in this study were due to similar mechanisms. Future studies may wish to consider recording mechanism of injury.

The average age of participants was found to be 23.65 years which is similar to other studies (Hopper, Hopper, et al., 1995; Hopper & Elliot, 1993). Hopper, Hopper, et al. (1995) provide some evidence to show that younger, elite netball players are at higher risk of being injured. Potential reasons could be growth factors, hormone levels, response to training load, and access to resources. This could be a factor in our cohort having low rates of injury.

The main finding from this study was the significant inverse relationship between injury risk and chronic load. Analysis of load and injury data show that as chronic load increases by one arbitrary unit, the odds of being injured decrease by 56.2%. This means players who have a history of high training loads have a decreased injury risk. This may be explained by the positive adaptations that occur from high training loads which are associated with a decrease in injury. These adaptations include an increase in aerobic capacity, muscular strength and increased tensile strength of soft tissue structures. A study found sub-elite rugby league players were at increased risk of sustaining an injury if they had a low off season VO2 max (Gabbett & Domrow, 2005). These results support previous studies in cricket, rugby league and AFL which all demonstrated high chronic loads decrease injury risk (Gabbett, 2010; Hulin et al., 2015; Hulin et al., 2014; Stares et al., 2018). Furthermore, in AFL players, low chronic load was associated with the greatest risk of injury regardless of whether the acute:chronic ratio was low or high (Stares et al., 2018). Gabbett and Domrow (2005) found that if an injury occurred before 18 weeks of pre-season had been completed that player was at risk of subsequent injury. This highlights the importance of pre-season training to gradually build athletes chronic load as players can tolerate increased load compared to during the season without increasing their risk of injury (Gabbett, 2010). Clinically this finding can be applied when an athlete is returning from an injury and when managing players training load.

In our study there was no statistically significant relationship between a ‘spike’ in acute load and increased injury risk which has been demonstrated in other studies. Commonly a ‘spike’ in training load is defined as periods where a player has an acute:chronic ratio of >1.5 (Blanch & Gabbett, 2016). However, individual players demonstrated this phenomenon. For example, player 04CP as represented in figure 3, in week 14 had a spike in acute load amounting to 4200 arbitrary units compared to a chronic load of 1369.5 arbitrary units for the corresponding week. This amounted to an acute:chronic ratio of 3.07 and a subsequent injury in the same week. Studies in elite cricket fast bowlers, rugby and AFL players found that there was an increased risk of injury when there were ‘spikes’ in training load (Gabbett, 2010; Hulin et al., 2015; Hulin et al., 2014; Stares et al., 2018). Gabbett (2017) described an acute:chronic ratio between 0.8 and 1.3 representing a ‘sweet spot’ of loading. Training in this zone has been demonstrated to elicit improvement in physical performance and maintain physical qualities that have a protective mechanism against injuries. This phenomenon debunks the idea that high workloads cause injury and relates the cause to improper programming. Our results support this theory as when chronic load increases (indicating a high workload over a period of time) risk of injury subsequently decreased. In our study, no individual player or team loading program was within the 'sweet spot' for the entirety of the season. This may have placed some players at unnecessary risk of injury.

Limitations

Several limitations should be considered when interpreting this studies results. Data collection from the three elite netball teams involved in the study was not comprehensive with a large portion of participants missing basic demographic data such as weight, age and position. Furthermore, a large percentage of the data had no load recorded for a particular day, at times for consecutive days with no injury recorded. This may represent missing data. The quality of data entered will ultimately determine the accuracy of the results. Secondly, this study calculated internal load through RPE multiplied by duration which is a subjective measurement. This may create bias depending on when the RPE was recorded in relation to when the training took place. Future studies may wish to include global positioning system data and markers of fatigue which are objective measures such as hormonal data. This would allow external load measures to be included. While an upper body weight training may produce the same perceived load as an on-court netball practice, the court practice is likely to better prepare the athlete for the demands of the competition. External load will better represent this theory and give a complete picture of the training load. Current literature has focused primarily on elite male athletes in sports such as rugby league, cricket and AFL. Comparisons between these studies should be considered in relation to differences between population and sporting code. The findings from this study have reduced statistical meaning due to the research design used. A cohort study was carried out to follow and record player data throughout the 2018 premiership season. Cohort designs produce lower quality evidence as they often limit the ability to control all variables that are not being measured. In this instance, all variables other than training load and injury incidence. This means there are other potential factors such as injury history, player contact, and training surfaces that may influence injury incidence and were not controlled. For example, if a player had sustained recurring ankle injuries in previous years, this may increase the risk of ankle injury in the 2018 season regardless of training load.

Practical Applications

For return to sport decisions, this study suggests that players' chronic load should be a consideration. Chronic load better informs the clinician on re-injury risk upon returning to sport. For example, a mild lateral ankle sprain may take six weeks to return to functional baseline but further time away from full participation may be needed to gradually build the athletes chronic load. Loading data can provide guidance for clinicians to prevent injuries. Athletes should be progressively loaded, with pre-season being the optimal time to do this to allow full participation throughout the season. Clinicians can increase load by training players in the ‘sweet spot’ which is within acute:chronic ratios between 0.8 and 1.3 arbitrary units. It is important to develop a robust method of monitoring and recording load to ensure data is accurate. Firstly, this will allow good comparisons within players and between players and sports. Secondly, with this data physiotherapists will be able to work closely with strength and conditioning coaches to ensure players are training within their ‘sweet spot’. This will improve the ability to prevent injury and allow players to continue performing optimally. We also recommend specifying the reason a player recorded no load within a day. This would allow missing data to be separated for genuine ‘rest days’ in future studies.

Conclusion

To our knowledge, this is the first study investigating the relationship between injury and training load in New Zealand elite netball. Our findings demonstrate a relationship between injury and chronic load, suggesting that high chronic loads may have a protective effect on injury. This shows that chronic load is an important variable for determining return to sport timeframes and how much load can be performed without increasing the risk of injury. Loading data to guide training programs and return to sport should not be used in isolation but considered with other clinical information to more accurately predict the athlete’s risk of injury. More accurate data collection and further research in this area is needed to improve the efficacy of the results.

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PHTY711 Research Project Contract

Student Name: Matthew Hawke
Student ID: 15898155

Student Name: Olivia Lobb
Student ID: 15907910

Date: 4/3/2019

Topic title: Injury incidence and training load in New Zealand elite netball

Name of supervisor(s):

STUDENT EXPECTATIONS
By signing this contract, we agree to complete this research project to the best of our ability. We agree to collaborate professionally, honestly, openly and to undertake the project with integrity. We agree to communicate frequently and to negotiate in a spirit of fairness and decency. We agree to maintain frequent, informed contact with our supervisor(s). We agree to 'drive' and actively lead the project, rather than 'follow' and be passive in our attitude.

Research Project due date**: Friday, August 30th, 2019**

TIME PLAN
Our timeframe for completing agreed tasks is set out as follows:

Date	Task	By whom
17/3/2019	Finished editing data	MH/OL
17/3/2019	Finished literature search	MH/OL
20/5/2019	Completed draft introduction	MH/OL
9/6/2019	Completed method and results draft	MH/OL
14/6/2019	Completed draft discussion and conclusion	MH/OL
11/8/2019	Finishing Editing the draft and handed in to supervisor	MH/OL
25/8/2019	Received feedback and final edits completed	MH/OL

IMPORTANT
If students cannot maintain equal contributions and this matter remains unresolved by the due date, then this must be brought to the attention of the Paper Leader who can assist with a process of resolution. If no resolution is found, the supervisor(s) retains the

right to assess students individually where there is deemed to be unequal workloads in student pairs.

SUPERVISOR EXPECTATIONS
As a supervisor, I agree to provide guidance on the project topic and methods, be available for regular meetings and to answer quick questions between meetings, and provide feedback on written work.

Supervisor Task	
Number of face-to-face/skype meetings agreed upon	4
Preferred form of contact	Email
Length of time to respond to an email/phone call	3
Length of time to provide feedback on written work	1 week
Dates away/unavailable	
Number of draft copies prepared to read	1 draft of each section and 1 final draft of the final report

Declaration
We agree that that the distribution of workload and supervisor expectations have been discussed and agreed upon as a group (students and supervisor). The research report and presentation will be marked as a “Group Assessment” and students in the group will be awarded the same grade for all learning outcomes.

SIGNATURES

Student name and signature:

Matthew Hawke

Date: 4/3/2019

Student name and signature:

Olivia Lobb

Date: 4/3/2019

Supervisor name and signature:

Duncan Reid

Date:4/3/19

This form must be completed, signed, and sent to your Supervisor by 4pm, Friday March 15th 2019.

SUPERVISION MEETING LOG

Attendees: **Matthew** **Olivia** **Duncan**	**Date: 28/2/2019**
Summary of discussion: **Ongoing improvement of the data** **How to conduct a literature search** **General dialogue on research process and timeline**	
On-going plans: **Email Mark** **Edit the data** **Do a literature search** **Contact Duncan and arrange a meeting**	**By whom?** **MH and OL**
Date of next meeting: Dependent on completion of plans	

What is the relationship between injury and training load in New Zealand elite netball?

Matthew Hawke & Olivia Lobb

Outline

- Introduction and current understanding
- Purpose of study
- Methods
- Results and discussion
- Limitations and practical applications

Figure 1: *NZ netball training*. From https://www.silverferns.co.nz/silver-ferns/news/latest-news/7109-silver-ferns-confirm-netball-world-cup-preparation-matches.html

Introduction

Figure 2: *World Cup winners.* From https://www.radiosport.co.nz/sport-news/netball/no-prize-money-for-world-champs-silver-ferns/

Netball in New Zealand

- World netball champions
- High injury incidence

Elite sports and training load

- High training load improves performance...and increases injury risk
- Dilemma for coaches and health professionals

Current Understanding

Emerging body of evidence

Original article

Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers

Billy T Hulin,[1] Tim J Gabbett,[1] Peter Blanch,[2] Paul Chapman,[3] David Bailey,[4] John W Orchard[5]

THE DEVELOPMENT AND APPLICATION OF AN INJURY PREDICTION MODEL FOR NONCONTACT, SOFT-TISSUE INJURIES IN ELITE COLLISION SPORT ATHLETES

TIM J. GABBETT[1,2]

[1]Brisbane Broncos Rugby League Club, Brisbane, Australia; and [2]School of Human Movement Studies, The University of Queensland, Brisbane, Australia

Original article

Editor's choice
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The acute:chronic workload ratio predicts injury: high chronic workload may decrease injury risk in elite rugby league players

Billy T Hulin,[1,2] Tim J Gabbett,[3,4] Daniel W Lawson,[2] Peter Caputi,[5] John A Sampson[1]

Identifying high risk loading conditions for in-season injury in elite Australian football players

Jordan Stares[a,b,*], Brian Dawson[a,b], Peter Peeling[a,e], Jarryd Heasman[b], Brent Rogalski[b], Michael Drew[c,d], Marcus Colby[a,b], Gregory Dupont[f], Leanne Lester[a]

Acute and Chronic Training Loads

Acute load

- Amount of training in a week

Chronic load

- Average training per week in the past month

Ratio

- $$\frac{\text{Acute load}}{\text{Chronic load}} = 1 \text{ or } >1 \text{ or } <1$$

Figure 3: *Silverfern in gym.* From https://www.netballnz.co.nz/news/detail/silver-ferns-honour-departing-physio

Injury Likelihood vs Training Load

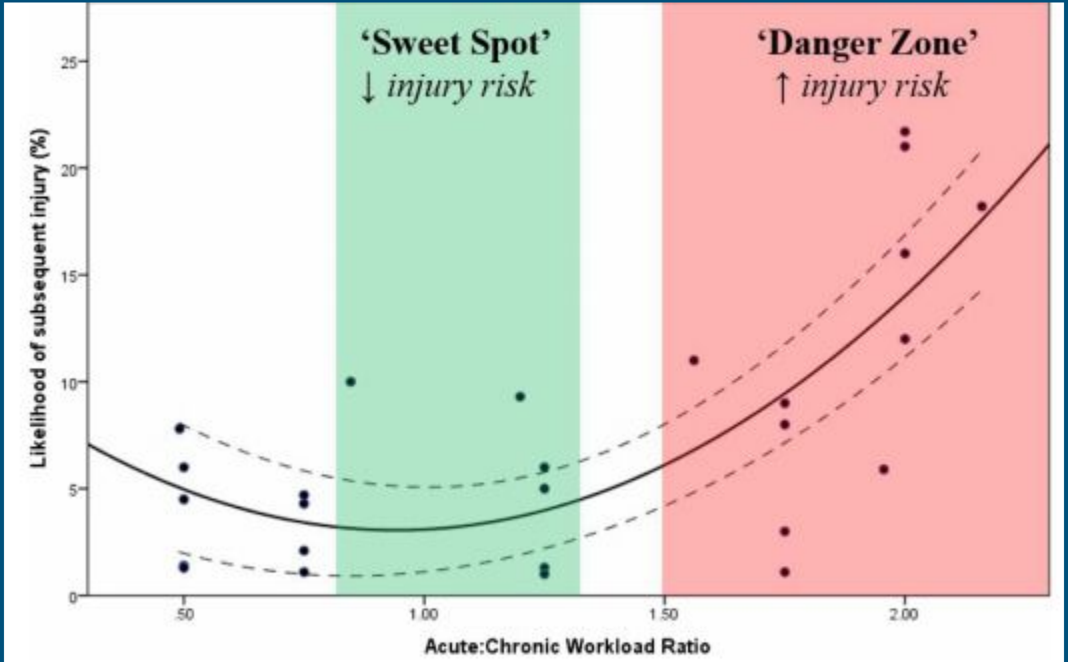

Figure 4: Sweet spot of training. Graph retrieved from Gabbett (2016).

Purpose

- To investigate the relationship between training load and injury incidence in elite netball players

Figure 5: *Investigating.* From https://galacticconnection.com/fbi-investigating-veteras-affairs-office-arizona

Methods

Data collected

- 32 players: injury incidence, training loads, demographics

Statistical analysis

- Descriptive statistics
- Logistic regression

Figure 6: *Central Pulse.* From https://www.pulse.org.nz/

Figure 7: *Northern Stars.* From https://www.facebook.com/NorthernStarsNetball/

Figure 8: *Mainland Tactix.* From https://en.wikipedia.org/wiki/Mainland_Tactix

Definitions

Injury

- Unable to complete a training session or game

Training load

- Rate of perceived exertion x duration of training/game
- RPE = 5, session duration = 60 minutes, training load = 300

1 - 10 Borg Rating of Perceived Exertion Scale	
0	Rest
1	Really Easy
2	Easy
3	Moderate
4	Sort of Hard
5	Hard
6	
7	Really Hard
8	
9	Really, Really, Hard
10	Maximal: Just like my hardest race

Figure 9: *Borg Scale*. From https://exercise.trekeducation.org/assessment/borg-scale-rpe/

SPSS Data

	WEEK	ATHLETE CODE	POSITION	AGE	WEIGHT	ACUTELOAD	CHRONIC LOAD	ACUTECHRONIC	INJURED
1	1.00	11.00	3.00	18.00	94.50	4260.00	.	.	1.00
2	2.00	11.00	3.00	18.00	94.50	3465.00	.	.	1.00
3	3.00	11.00	3.00	18.00	94.50	3240.00	.	.	1.00
4	4.00	11.00	3.00	18.00	94.50	2040.00	3251.25	.63	2.00
5	5.00	11.00	3.00	18.00	94.50	3720.00	3116.25	1.19	1.00
6	6.00	11.00	3.00	18.00	94.50	3840.00	3210.00	1.20	1.00
7	7.00	11.00	3.00	18.00	94.50	4320.00	3480.00	1.24	1.00
8	8.00	11.00	3.00	18.00	94.50	4950.00	4207.50	1.18	1.00
9	9.00	11.00	3.00	18.00	94.50	4740.00	4462.50	1.06	1.00
10	10.00	11.00	3.00	18.00	94.50	2610.00	4155.00	.63	1.00
11	11.00	11.00	3.00	18.00	94.50	4770.00	4267.50	1.12	1.00
12	12.00	11.00	3.00	18.00	94.50	4267.50	4096.88	1.04	1.00
13	13.00	11.00	3.00	18.00	94.50	2520.00	3541.88	.71	2.00
14	14.00	11.00	3.00	18.00	94.50	3570.00	3781.88	.94	2.00
15	15.00	11.00	3.00	18.00	94.50	2715.00	3268.13	.83	1.00
16	16.00	11.00	3.00	18.00	94.50	2723.50	2882.13	.94	1.00
17	17.00	11.00	3.00	18.00	94.50	3110.00	3029.63	1.03	1.00
18	18.00	11.00	3.00	18.00	94.50	2642.00	20797.63	.94	1.00

Figure 10: *SPSS Data*

Results

Injury statistics:

- 43 injuries
- 72% categorised as “slight”
- Main areas of injury: ankle and knee

Main finding:

- Statistically significant relationship between high chronic load and reduced risk of injury.

Figure 11: *Ankle injury in netball.* From https://injuryactive.com/netball-and-ankle-instability/

Discussion

Low injury rate

- Players may have been well managed

Main finding: ↑ Chronic loads ↓ Injury rates

- This result supports findings in previous studies

Positive adaptations from high loads

- High aerobic capacity
- Increased muscular strength
- Increased tensile strength of soft tissue structures

Figure 12: *Muscular strength.* Fromhttps://www.t-nation.com/training/tip-build-bigger-biceps-with-isometrics

Figure 13: *Fitness test.* From https://www.therunningcenter.com/vo2-max-testing-max-heart-rate-testing/

Gabbett, T. J., & Domrow, N. (2005) Risk factors for injury in sub-elite rugby league players. *American Journal of Sports Medicine, 33*, 428—434. doi: 10.1177/0363546504268407

Player Example

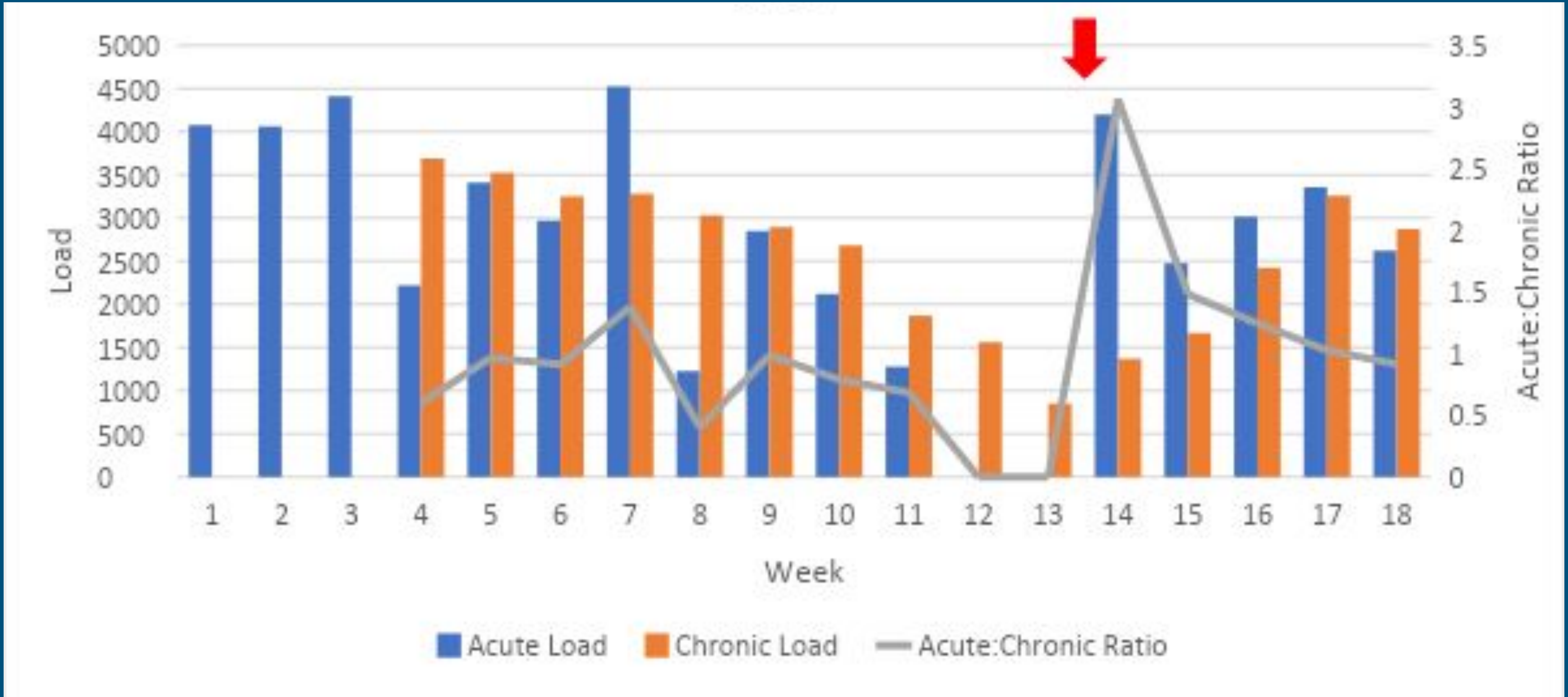

Figure 14: *Player Example*

Limitations

Data collection

- Missing data

Training Load

- Potential bias with current measurement
- Alternative methods of calculating load

Figure 15: *Missing Data*. From http://www.jordicasanellas.com/data-science-blog/missing-data-impute-or-do-not-impute-r-examples

Limitations

Figure 16: *Apples and oranges.* From http://theconversation.com/apples-and-oranges-comparing-our-education-system-with-other-countries-doesnt-always-work-31174

Comparisons between literature

- Differing methods for measuring load

Cohort design

- Reduced quality due to limitations

Practical Applications

Demographic information

- Weight, age and position

Load data

- Record reason for “no load” days
- Collaborative approach: Physio, S&C and player
- Multiple load parameters

Figure 17: *Silverferns.* From https://www.newshub.co.nz/home/sport/2019/07/netball-world-cup-champion-silver-ferns-crammed-into-economy-class-for-trip-home.html

Practical Applications

Return to sport decisions

- Time frames

Injury prevention

- Building chronic load

Training loads

- Acute/Chronic ratio: 0.8-1.3 arbitrary units

Figure 18: Strapped ankle. From https://www.youtube.com/watch?v=kxSo4pDcoOY

Questions?