Award No. N000141110929
Office of Naval Research

The Musculoskeletal Injury Epidemiology of the NSW Student and Operator (Self-Report Survey Data)

September 21, 2015

Prepared for
Naval Special Warfare Command
Coronado, CA

Prepared by the Faculty of the
Department of Sports Medicine and Nutrition
School of Rehabilitation Sciences
University of Pittsburgh

Submitted by: Timothy C. Sell, PT, PhD (PI)
Phone: (412) 246-0460
E-mail: tcs15@pitt.edu

Disclosures Page

This document has been created to serve as technical report of the self-reported injury data as part of the Naval Special Warfare Tactical Athlete Program Human Performance and Injury Prevention Research Initiative conducted by the University of Pittsburgh's Department of Sports Medicine and Nutrition. This technical report includes research results, methodologies utilized for data collection, and general guidelines for human performance and medical practitioners. Opinions, interpretations, conclusions, and recommendations are those of the authors and do not represent the official policy or position of the Department of Defense, the Office of Naval Research, or Naval Special Warfare. This work was supported by the Office of Naval Research, Grant Award Number N000141110929.

Executive Summary

Subject: University of Pittsburgh's Naval Special Warfare Injury Prevention and Human Performance Research Initiative Injury Epidemiology Report

1. The purpose of this report is to describe musculoskeletal injuries in a population of Naval Special Warfare (NSW) Students and Operators
2. Methods:
   - 2.1. Self-reported musculoskeletal injury data from the previous one-year were captured from individual participants during a clinician-guided interview
   - 2.2. All participants were NSW Students or Operators, and are part of a larger collaborative study between NSW and the University of Pittsburgh
     - 2.2.1. Sea, Air, Land (SEAL) Operator data were collected at Group 2 (G2: 378 Operators surveyed)
     - 2.2.2. Special Warfare Combatant-craft Crewman (SWCC) data were collected at Special Boat Team 22 (SBT-22: 142 Operators surveyed)
     - 2.2.3. SEAL and SWCC Qualification Training (SQT and CQT respectively) Student data were collected at NSW Center (SQT: 354 and CQT: 187 Students surveyed)
   - 2.3. Additional data (beyond the previous one-year) were captured from SQT and CQT Students in order to describe injuries sustained during their respective training pipelines
3. Results:
   - 3.1. This analysis describes 367 injuries reported by 289 NSW Students and Operators
   - 3.2. The majority of individual Students and Operators (772 of 1,061 surveyed) did not report an injury during the one-year prior to survey
   - 3.3. Injury frequency and injury incidence in Students were much higher than among Operators
   - 3.4. The major anatomic locations injured among all Students and Operators were the lower extremity, upper extremity, and spine
     - 3.4.1. SQT Students and G2 Operators had a major concentration of injuries to the shoulder, ankle, and lumbopelvic region
     - 3.4.2. CQT Students and SBT-22 Operators had a major concentration of injuries to the shoulder, knee, lower leg (CQT Students only), and lumbopelvic region (SBT-22 Operators only)
   - 3.5. Most injuries occurred during physical training for all groups except G2 Operators (most G2 Operators were injured during recreational activities / sports)
     - 3.5.1. Physical training accounted for a much higher percentage of injuries among Students than among operators
     - 3.5.2. Most SQT and CQT Student injuries during physical training were a result of running
     - 3.5.3. Most G2 and SBT-22 Operator injuries were a result of lifting
   - 3.6. Sprains and strains were the most common type of injury among SQT Students and G2 Operators; pain/spasm/ache was the most common type of injury among CQT Students and SBT-22 Operators
     - 3.6.1. When all Student training pipeline data is considered (beyond the previous one-year), stress fractures are the most common type of injury for CQT and SQT Students
     - 3.6.2. The majority of injuries reported by all groups had an acute onset
     - 3.6.3. The majority of injuries reported by Students during training pipelines had an acute onset and were classified as overuse (an injury caused by excessive or unaccustomed activity and relieved by rest)

3.7. Most injuries reported did not result in any time lost
    3.7.1. Of those injuries associated with time lost, most resulted in less than three weeks of lost training days, except for G2 Operators and CQT Students
    3.7.2. G2 Operators reported the most surgeries associated with injuries and CQT Students reported the most lower extremity stress fractures (during the one-year reporting period), which most likely accounts for the large loss of training days in these groups
    3.7.3. See Appendix A for complete SQT and CQT Student data, including time lost for rolls
4. Recommendations:
    4.1. Injuries most commonly occur at the shoulder, lumbopelvic region, and lower extremity
        4.1.1. Many of the injuries to the lower extremity and shoulder occur during physical training | while running or lifting weights
    4.2. Injury prevention strategies should include strengthening, flexibility, neuromuscular control, postural stability, and functional exercises/activities, in addition to education regarding rest and recovery strategies
        4.2.1. Injury prevention relative to physical training may require modification to technique (or monitoring of technique), examination of volume of training, and/or substitution of alternative exercises/activities

Table of Contents

Chapter 1. Introduction

A career in the armed forces is demanding given the wide range of mission requirements and service members must maintain a high level of physical readiness to meet operational demands.[1] Military personnel face a broad spectrum of injury and medical risks due to their service; unintentional musculoskeletal injuries, due to either physical or tactical training, are the largest cause of lost duty days[2-6] and are the single largest health concern facing the Department of Defense.[7-12] Although injury epidemiology among U.S. military personnel has been well researched,[2-4, 7, 12-21] limited published data describe injury patterns among Special Operations Forces (SOF). These elite Operators execute a diverse mission set worldwide and must maintain a heightened state of readiness year round. The operational demand among SOF exceeds that of conventional forces.[22-25] Studies have demonstrated that a large percentage of medical complaints in these Operators are related to musculoskeletal injuries,[24] many injuries are severe enough that they require surgery and have an associated loss of time,[25] and many of these injuries occur during pre-deployment training.[23] Musculoskeletal injuries can predispose individuals to secondary and recurrent injury and contribute significantly to morbidity, loss of duty days, disability, and negatively impact tactical and physical readiness.[5, 6, 10, 11, 13-16, 18, 26-29] In order to quantify changes in injury risk over the course of an Operator's career, it is important to understand the type and frequency of injuries incurred during initial entry training[30] and through various training and deployment cycles.[23]

Consistent with the public health approach to injury prevention and control,[7, 16, 17] the University of Pittsburgh Human Performance and Injury Prevention Research Initiative with Naval Special Warfare (NSW) was initiated to accomplish three objectives: (1) minimize the number and severity of NSW Operator injuries; (2) maximize performance and combat readiness; and (3) enhance the career longevity and quality of life during and following service. In order to accomplish these objectives, a research model that includes four phases was outlined. These research phases are scientifically designed to follow a traditional but modified approach to injury prevention and control, which insures that research, is culturally specific and meets the demands of the Operator.[31] Phase 1 of this model includes an epidemiological study of Operator injuries in order to understand the magnitude, nature, and impact of the injury problem.[31] Injury data, such as types of injuries, locations, and activities/mechanisms of injuries are necessary for clinicians and operators to understand injury epidemiology in their community. Further, because of limitations in the Armed Forces Health Longitudinal Technology Application (AHLTA) and categories of injury diagnoses using the International Classification of Diseases, Ninth revision, Clinical Modification (ICD-9-CM), intricate information such as activities and mechanisms of injuries when injuries occurred have not been well examined in NSW Operators. Therefore, the purpose of this analysis was to describe the injury epidemiology among NSW Operators and Students using self-reported injury histories. Clinically, injury epidemiology will assist in refining laboratory protocols in subsequent research phases and ultimately identify the priorities necessary for refinement of NSW's physical training program to reduce musculoskeletal injuries and enhance force readiness.

Chapter 2. Methods

Participants

All participants were Sea, Air, Land (SEAL) or Special Warfare Combatant-craft Crewman (SWCC) or Students in the respective training pipelines and are part of a larger collaborative study between NSW and the University of Pittsburgh. Group 2 (G2) SEAL Operator data were collected at the Warrior Human Performance Research Laboratory (WHPRL) located at Joint Expeditionary Base Little Creek-Fort Story, Virginia. Group 4, Special Boat Team 22 (SBT-22) SWCC Operator data were collected at the WHPRL located at the John C. Stennis Space Center, Mississippi. All Student participants were in either the SEAL Qualification Training (SQT) or Crewman Qualification Training (CQT) pipelines or recent graduates (within three months of graduation); data were collected at the WHPRL located at Naval Amphibious Base Coronado, California. All Operators and Students were cleared for full duty and voluntarily consented to participate in the study after one of the investigators explained the purpose, details, and procedures. Human subject protection approvals were obtained by the Institutional Review Board of the University and Human Research Protection Office at the Office of Naval Research.

Protocol

Self-reported musculoskeletal injury data from the previous one-year were captured from individual participants during a clinician-guided interview. A one-year period was selected in order to capture as much of the training and operational cycle as possible, while limiting issues due to recall bias associated with longer time frames.[32-34] These data were obtained as a part of a comprehensive human performance laboratory test protocol, consisting of biomechanical, musculoskeletal strength and flexibility, balance, physiological, and nutrition assessments. Demographic data (including service history), medical, injury, physical training history, and nutrition habits were collected using the University of Pittsburgh Military Epidemiology Database (UPitt-MED), which is a customized data management system. Injury data were entered into UPitt-MED by clinically trained research faculty to ensure an accurate and thorough injury history.

Demographic data for all participants are presented in **Table 1**. The UPitt-MED survey includes questions about injury anatomic location, anatomic sub-location, injury type, activity during which injury occurred, cause of injury, type of onset of injury, mechanism of injury, treatment received, and days of training missed due to injury. Additional questions about circumstances surrounding the injury include self-perceived fatigue, hydration status, nutritional status, and if load or load carriage contributed to the injury. A copy of the UPitt-MED survey is available upon request.

Table 1. Participant demographics

	SQT	Group 2	CQT	SBT-22
N	354	378	187	142
Age (years)	24.3 ± 2.7	28.3 ± 5.5	22.8 ± 3.2	26.9 ± 5.9
Height (inches)	70.6 ± 2.6	70.2 ± 2.5	70.1 ± 2.7	71.3 ± 10.6
Weight (pounds)	187.2 ± 18.6	189.4 ± 21.6	180.4 ± 18.3	187.5 ± 24.2
Years Active*	2.1 ± 1.6	6.5 ± 5.2	1.2 ± 1.2	5.1 ± 3.9

Age, height, weight, and years active reported as mean ± standard deviation

*years of active duty (years active) were calculated for 347 SQT Students, 306 G2 Operators, 162 CQT Students, and 139 SBT-22 Operators. Individuals reporting <1yr of active duty were calculated as having 6 months of service; individuals reporting 21+ years of active duty were counted as having 22 years of service.

Definitions

An **injury**, for the purpose of this study and this report, is an unintentional injury to the musculoskeletal system (bones, ligaments, muscles, tendons, etc.) that, if occurring after enlistment, resulted in alteration in physical training, tactical training, or tactical activities for a minimum of one day, regardless if medical attention was sought.[22] If the injury occurred before enlistment, the injury resulted in alteration in activities of daily living and/or training/athletic activities for a minimum of one day, regardless if medical attention was sought. This definition is consistent with other musculoskeletal injury epidemiological studies[35, 36] and includes conditions such as sprains, strains, and fractures, but not contusions, lacerations, or concussions.[22] All injuries meeting this operational definition and reported within one year of survey date are referred to as **AllInj** in this manuscript. In order to avoid over-counting or over-reporting injuries, bilateral injuries were counted as a single injury. AllInj are described relative to injury location, sub-location, and type, as well as categorized as acute/chronic, overuse, and contact/non-contact. **Location** and **sub-location** are gross anatomic region and specific joint/segment where the injury occurred while the type is the specific injury sustained (e.g. upper extremity, shoulder, sprain; lower extremity, lower leg, fracture). Injuries where symptoms lasted less than six months are **acute** while those that lasted six or more months are **chronic**. **Overuse** injuries are caused by excessive or unaccustomed activity, exacerbated by this activity, and relieved by rest. **Contact** are injuries where contact with another person or an external object (excluding the ground) caused the injury; this includes both direct (e.g. a kick to the knee resulting in an MCL sprain) and indirect mechanisms (e.g. a takedown during combatives with upper body contact causing twisting around a planted foot resulting in an MCL sprain). An example of a **non-contact** injury is a knee MCL sprain caused by planting and cutting to change direction while running. The **activity** when the injury occurred provides information on the category of activity individuals were engaged in when the injury was sustained (e.g. physical training, recreational activities), while the **injury cause** provides information regarding the circumstances in which the injury occurred (e.g. running, climbing, lifting, jumping, landing).

After data collection was completed, injuries were further classified as preventable or not preventable in order to promote development of physical training programs that improve modifiable neuromuscular and physiological characteristics related to risk of musculoskeletal injury. To address this aim, a holistic approach was taken when classifying injuries using available information (e.g., location, sub-location, type, cause, activity, contact/non-contact, available description of the injury/incident). In this study, **preventable injuries (PrevInj)** are defined as those injuries that had the potential to have been prevented through programs developed to improve neuromuscular and physiological characteristics related to risk of musculoskeletal injury.[22] Examples of PrevInj include lower extremity stress fractures resulting from running and/or marching and non-contact knee ligament injuries. **Not preventable injuries** are musculoskeletal injuries not able to be deterred through these injury prevention programs (e.g. those sustained during motor vehicle accidents, direct trauma, most fractures to the face, fingers, or toes), or those injuries reported with insufficient details about the incident to determine if the injury could have been prevented (e.g. knee sprain during an unspecified activity with an unknown cause). Although some of the injuries classified in this study as not preventable may be prevented through other intervention strategies, such as sleep modification or changes in equipment, these injuries would not be preventable through physical training programs. The post-data collection classification of AllInj into PrevInj and not preventable categories was completed by a Certified Athletic Trainer with 22 years of experience at the collegiate level (Divisions I and III), a doctorate in rehabilitation science (sports medicine and nutrition), and seven years of experience working on Department of Defense related grants at the University of Pittsburgh.

AllInj reported in this manuscript refer to all musculoskeletal injuries reported by Students and Operators during the one-year reporting period covered by this report. PrevInj reported in this manuscript refer to the subset of reported AllInj that have been classified as preventable.

Injury Data

Self-reported AllInj data during the one-year period prior to the date of survey are presented in **Chapter 3 (Results)**. The description of all AllInj and PrevInj included the calculation of relative frequency (percent) of injuries. Injury frequency was calculated as the number of injuries per 100 subjects per year. Injury incidence was calculated as the number of subjects injured per 100 subjects per year. Description of anatomic location, anatomic sub-location, cause of injury, activity when injury occurred, injury type, and whether fatigue, hydration, nutrition, and load carriage may have been part of the cause of injury are also presented. Additionally, AllInj sustained by SQT and CQT Students during their respective training pipelines are presented in **Appendix A (SQT and CQT Student Injuries by Training Phase)**. This appendix includes AllInj reported by Students during physical and tactical training since their date of enlistment (greater than one-year prior to the date of survey to accommodate the length of the training pipeline). Finally, a description of the physical training PrevInj reported by all four groups during the one-year reporting period is included in **Appendix B (Physical Training Injuries)**.

Chapter 3. Results

This report describes self-reported AllInj within one-year prior to the date of survey reported by 354 SQT Students, 378 SEALs at G2, 187 CQT Students, and 142 SWCCs at SBT-22. Students reported an average of approximately two years of active duty service, and were mostly E-3 (32.8% of SQT Students, 36.4% of CQT Students) and E-4 (29.7% of SQT Students, 49.7% of CQT Students). Operators reported an average of approximately six years of active duty service, and were mostly E-6 (36.0% of G2 Operators, 47.2% of SBT-22 Operators) and E-7 (18.3% of G2 Operators, 27.5% of SBT-22 Operators). Surveys were performed between February 2008 and May 2015 and this report includes AllInj reported between July 2007 and May 2015. The number AllInj and PrevInj (relative frequency of subjects) during the one-year period prior to the survey date are reported in **Table 2** and **Table 3** respectively.

Table 2. AllInj frequency during a one-year period (relative frequency of subjects)

Number of AllInj	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
0	246	69.5	295	78.0	117	62.6	114	80.3
1	87	24.6	72	19.0	45	24.1	20	14.1
2	16	4.5	9	2.4	22	11.8	8	5.6
3	3	0.8	2	0.5	3	1.6	0	0.0
4	1	0.3	0	0.0	0	0.0	0	0.0
5	1	0.3	0	0.0	0	0.0	0	0.0
Total	**354**		**378**		**187**		**142**	

Table 3. PrevInj frequency during a one-year period (relative frequency of subjects)

Number of PrevInj	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
0	287	81.1	341	90.2	134	71.7	122	85.9
1	59	16.7	36	9.5	35	18.7	18	12.7
2	7	2.0	1	0.3	16	8.6	2	1.4
3	0	0.0	0	0.0	2	1.1	0	0.0
4	0	0.0	0	0.0	0	0.0	0	0.0
5	1	0.3	0	0.0	0	0.0	0	0.0
Total	**354**		**378**		**187**		**142**	

One hundred and eight SQT Students reported at least one AllInj in the one-year period prior to the survey date, for a total of 137 AllInj during the reporting period. The majority of SQT Students (69.5%) did not report an injury. A total of 67 SQT Students reported at least one AllInj that was classified as preventable, for a total of 78 PrevInj during the reporting period. Overall, 56.9% of the AllInj that were reported were classified as preventable. Eighty-three G2 Operators reported at least one AllInj in the one-year period prior to the survey date, for a total of 96 AllInj during the reporting period. The majority of G2 Operators (78.0%) did not report an AllInj. A total of 37 G2 Operators reported at

least one AllInj that was classified as preventable, for a total of 38 PrevInj during the reporting period. Overall, 39.6% of the AllInj that were reported were classified as preventable.

Seventy CQT Students reported at least one AllInj in the one-year period prior to the survey date, for a total of 98 AllInj during the reporting period. The majority of CQT Students (62.6%) did not report an AllInj. A total of 53 CQT Students reported at least one AllInj that was classified as preventable, for a total of 73 PrevInj during the reporting period. Overall, 74.5% of the AllInj that were reported were classified as preventable. Twenty-nine SBT-22 Operators reported at least one AllInj in the one-year period prior to the survey date, for a total of 36 AllInj during the reporting period. The majority of SBT-22 Operators (79.7%) did not report an AllInj. A total of 20 SBT-22 Operators reported at least one AllInj that was classified as preventable, for a total of 21 PrevInj during the reporting period. Overall, 58.3% of the AllInj that were reported were classified as preventable.

Injury Frequency and Incidence

The AllInj and PrevInj frequency (number of injuries per 100 subjects per year) and incidence (number of injured subjects per 100 subjects per year) are listed in **Table 4**.

Table 4. AllInj and PrevInj frequency and incidence

	SQT		Group 2		CQT		SBT-22	
	AllInj	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**
Injury frequency	137/354	78/354	96/378	38/378	98/187	73/187	36/142	22/142
	38.7%	22.0%	25.4%	10.1%	52.4%	39.0%	25.4%	15.5%
Injury incidence	108/354	67/354	83/378	37/378	70/187	53/187	28/142	20/142
	30.5%	18.9%	22.0%	9.8%	37.4%	28.3%	19.7%	14.1%

Injury frequency: Number of injuries/100 subjects/year
Injury incidence: Number of injured subjects/100 subjects/year

According to this self-reported AllInj data, approximately 30.5% of SQT Students, 22.0% of G2 Operators, 37.4% of CQT Students, and 19.7% of SBT-22 Operators will suffer at least one injury each year. Of those injured, approximately two-thirds of SQT Students, half of the G2 Operators, and three-quarters of CQT Students and SBT-22 Operators will suffer a preventable injury.

Injury Anatomic Location and Sub-location

The primary anatomic location of all AllInj and PrevInj are listed in **Tables 5** and **6** respectively. The anatomic sub-location of AllInj and PrevInj are listed in **Tables 7** and **8** respectively.

Table 5. Anatomic location of AllInj

AllInj anatomic location	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Lower Extremity	68	49.6	38	39.6	65	66.3	19	52.8
Upper Extremity	37	27	34	35.4	24	24.5	11	30.6
Spine	21	15.3	17	17.7	9	9.2	5	13.9
Torso	7	5.1	6	6.3	0	0.0	1	2.8
Head/Face	2	1.5	1	1.0	0	0.0	0	0.0
Unknown	2	1.5	0	0.0	0	0.0	0	0.0
Total	**137**		**96**		**98**		**36**	

Table 6. Anatomic location of PrevInj

PrevInj anatomic location	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Lower Extremity	47	60.3	16	42.1	59	80.8	11	50.0
Upper Extremity	16	20.5	12	31.6	11	15.1	7	31.8
Spine	14	17.9	10	26.3	3	4.1	4	18.2
Torso	1	1.3	0	0.0	0	0.0	0	0.0
Head/Face	0	0	0	0.0	0	0.0	0	0.0
Unknown	0	0	0	0.0	0	0.0	0	0.0
Total	**78**		**38**		**73**		**22**	

The three most common anatomic locations for AllInj were the lower extremity, upper extremity, and spine for all four groups. The lower extremity accounted for the largest percentage of PrevInj, followed by upper extremity and spine.

Table 7. Anatomic sub-location of AllInj

AllInj anatomic location	Anatomic sub-location	SQT		Group 2		CQT		SBT-22	
		n	%	n	%	n	%	n	%
Lower extremity	Hip	5	3.6	3	3.1	3	3.1	0	0.0
	Thigh	6	4.4	7	7.3	9	9.2	4	11.1
	Knee	13	9.5	6	6.3	15	15.3	11	30.6
	Lower Leg	7	5.1	3	3.1	20	20.4	1	2.8
	Ankle	23	16.8	14	14.6	11	11.2	3	8.3
	Foot/Toes	14	10.2	5	5.2	7	7.1	0	0.0
Upper extremity	Shoulder	23	16.8	17	17.7	16	16.3	8	22.2
	Upper Arm	0	0.0	0	0.0	1	1.0	1	2.8
	Elbow	3	2.2	5	5.2	0	0.0	0	0.0
	Forearm	1	0.7	2	2.1	0	0.0	0	0.0
	Wrist	6	4.4	6	6.3	2	2.0	0	0.0
	Hand/Fingers	4	2.9	4	4.2	5	5.1	2	5.6
	Other	0	0.0	0	0.0	0	0.0	0	0.0
Spine	Cervical	1	0.7	4	4.2	2	2.0	0	0.0
	Thoracic	1	0.7	4	4.2	0	0.0	0	0.0
	Lumbopelvic	19	13.9	8	8.3	7	7.1	5	13.9
	Other	0	0.0	1	1.0	0	0.0	0	0.0
Torso	Chest	5	3.6	4	4.2	0	0.0	1	2.8
	Abdomen	2	1.5	2	2.1	0	0.0	0	0.0
	Other	0	0.0	0	0.0	0	0.0	0	0.0
Head/ face	Nose	2	1.5	0	0.0	0	0.0	0	0.0
	Unknown	0	0.0	1	1.0	0	0.0	0	0.0
Unknown	Unknown	2	1.5	0	0.0	0	0.0	0	0.0
	Total	**137**		**96**		**98**		**36**	

Table 8. Anatomic sub-location of PrevInj

PrevInj anatomic location	Anatomic sub-location	SQT		Group 2		CQT		SBT-22	
		n	%	n	%	n	%	n	%
Lower extremity	Hip	4	5.1	1	2.9	2	2.7	0	0.0
	Thigh	6	7.7	7	18.4	9	12.3	4	18.2
	Knee	5	6.4	3	7.9	12	16.4	6	27.3
	Lower Leg	7	9.0	2	5.3	20	27.4	1	4.5
	Ankle	15	19.2	3	7.9	9	12.3	0	0.0
	Foot/Toes	10	12.8	0	0.0	7	9.6	0	0.0
Upper extremity	Shoulder	14	17.9	8	21.1	9	12.3	6	27.3
	Upper Arm	0	0.0	0	0.0	1	1.4	1	4.5
	Elbow	2	2.6	2	5.3	0	0.0	0	0.0
	Forearm	0	0.0	0	0.0	0	0.0	0	0.0
	Wrist	0	0.0	2	5.3	1	1.4	0	0.0
	Hand/Fingers	0	0.0	0	0.0	0	0.0	0	0.0
	Other	0	0.0	0	0.0	0	0.0	0	0.0
Spine	Cervical	1	1.3	1	2.6	0	0.0	0	0.0
	Thoracic	0	0.0	2	5.3	0	0.0	0	0.0
	Lumbopelvic	13	16.7	7	18.4	3	4.1	4	18.2
	Other	0	0.0	0	0.0	0	0.0	0	0.0
Torso	Chest	0	0.0	0	0.0	0	0.0	0	0.0
	Abdomen	1	1.3	0	0.0	0	0.0	0	0.0
	Other	0	0.0	0	0.0	0	0.0	0	0.0
Head/ face	Nose	0	0.0	0	0.0	0	0.0	0	0.0
	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
Unknown	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Total	**78**		**38**		**73**		**22**	

For SQT Students, the ankle accounted for the highest percentage of AllInj and PrevInj, followed by the shoulder and lumbopelvic region. For G2 Operators, the shoulder accounted for the highest percentage of AllInj, followed by the ankle and lumbopelvic region. When only PrevInj were considered, shoulder injuries accounted for the highest percentage, followed by the lumbopelvic region and thigh. For CQT Students, the lower leg accounted for the highest percentage of AllInj and PrevInj, followed by the shoulder and knee for AllInj, and followed by the shoulder, thigh, and ankle for PrevInj. For SBT-22 Operators, the knee and shoulder accounted for the highest percentage of AllInj and PrevInj, followed by the lumbopelvic region and thigh.

Activity When Injury Occurred

The activity Students and Operators were engaged in when the AllInj and PrevInj occurred are listed in **Tables 9** and **10** respectively.

Table 9. Activity when AllInj occurred

Activity	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Combat	0	0.0	5	5.2	1	1.0	3	8.3
Motor Vehicle Accident	0	0.0	0	0.0	0	0.0	1	2.8
Occupational Tasks	1	0.7	0	0.0	1	1.0	3	8.3
Physical Training	75	54.7	23	24.0	76	77.6	12	33.3
Recreational Activity / Sports	23	16.8	29	30.2	6	6.1	8	22.2
Tactical Training	31	22.6	14	14.6	12	12.2	4	11.1
Other	6	4.4	18	18.8	1	1.0	5	13.9
Unknown	1	0.7	7	7.3	1	1.0	0	0.0
Total	**137**		**96**		**98**		**36**	

Table 10. Activity when PrevInj occurred

Activity	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Combat	0	0.0	0	0.0	1	1.4	1	4.5
Motor Vehicle Accident	0	0.0	0	0.0	0	0.0	0	0.0
Occupational Tasks	0	0.0	0	0.0	1	1.4	3	13.6
Physical Training	56	71.8	18	47.4	62	84.9	11	50.0
Recreational Activity / Sports	12	15.4	9	23.7	5	6.8	5	22.7
Tactical Training	8	10.3	2	5.3	4	5.5	1	4.5
Other	2	2.6	8	21.1	0	0.0	1	4.5
Unknown	0	0.0	1	2.6	0	0.0	0	0.0
Total	**78**		**38**		**73**		**22**	

Physical training accounted for the highest percentage of AllInj for all groups except G2 Operators, and the highest percentage of PrevInj for all groups. For both SQT and CQT Students, tactical training accounted for the second highest percentage of AllInj, but the third highest percentage of PrevInj, with recreational activity/sports accounting for the third highest percentage of AllInj and second highest percentage of PrevInj. Recreational activity/sports accounted for the second highest percentage of PrevInj in G2 and SBT-22 Operators, followed by other activities (e.g. unloading a truck, walking) for G2 Operators and occupational tasks for SBT-22 Operators.

Cause of Injury

The cause of injury for AllInj and PrevInj are listed in **Table 11** and **12** respectively.

Table 11. Cause of AllInj

Cause of AllInj	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Compression from Boating	0	0.0	0	0.0	1	1.0	0	0.0
Climbing	0	0.0	1	1.0	2	2.0	0	0.0
Crushing	1	0.7	2	2.1	2	2.0	0	0.0
Cutting	0	0.0	1	1.0	0	0.0	0	0.0
Direct Trauma	13	9.5	8	8.3	5	5.1	4	11.1
Fall - Different Level	2	1.5	1	1.0	3	3.1	1	2.8
Fall - Same Level	8	5.8	3	3.1	1	1.0	1	2.8
Fall - Other	1	0.7	11	11.5	0	0.0	1	2.8
Jump	2	1.5	0	0.0	0	0.0	1	2.8
Landing	9	6.6	4	4.2	0	0.0	1	2.8
Lifting	26	19.0	18	18.8	8	8.2	9	25.0
Marching	2	1.5	0	0.0	0	0.0	1	2.8
Planting	3	2.2	0	0.0	1	1.0	2	5.6
Pulling	2	1.5	2	2.1	2	2.0	1	2.8
Running	39	28.5	9	9.4	54	55.1	6	16.7
Twist/Turn/Slip (no fall)	0	0.0	4	4.2	1	1.0	2	5.6
Whiplash	0	0.0	0	0.0	2	2.0	0	0.0
Other	17	12.4	9	9.4	13	13.3	3	8.3
Unknown	12	8.8	23	24.0	3	3.1	3	8.3
Total	**137**		**96**		**98**		**36**	

Table 12. Cause of PrevInj

Cause of PrevInj	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Compression from Boating	0	0.0	0	0.0	0	0.0	0	0.0
Climbing	0	0.0	1	2.6	1	1.4	0	0.0
Crushing	0	0.0	0	0.0	0	0.0	0	0.0
Cutting	0	0.0	1	2.6	0	0.0	0	0.0
Direct Trauma	0	0.0	0	0.0	0	0.0	0	0.0
Fall - Different Level	0	0.0	0	0.0	0	0.0	0	0.0
Fall - Same Level	0	0.0	0	0.0	0	0.0	0	0.0
Fall - Other	0	0.0	0	0.0	0	0.0	0	0.0
Jump	1	1.3	0	0.0	0	0.0	1	4.5
Landing	3	3.8	1	2.6	0	0.0	0	0.0
Lifting	24	30.8	16	42.1	8	11.0	9	40.9
Marching	0	0.0	0	0.0	0	0.0	1	4.5
Planting	2	2.6	0	0.0	1	1.4	1	4.5
Pulling	2	2.6	1	2.6	2	2.7	0	0.0
Running	34	43.6	8	21.1	54	74.0	6	27.3
Twist/Turn/Slip (no fall)	0	0.0	0	0.0	1	1.4	1	4.5
Whiplash	0	0.0	0	0.0	0	0.0	0	0.0
Other	7	9.0	5	13.2	6	8.2	2	9.1
Unknown	3	3.8	5	13.2	0	0.0	1	4.5
Total	**78**		**38**		**73**		**22**	

Most SQT Student AllInj were caused by running (28.5% of AllInj, 87.2% of which were preventable), followed by lifting and other causes (e.g. finning, punching during combatives) respectively. Most G2 Operator AllInj were from unknown causes, followed by lifting (18.8% of AllInj, 88.9% of which were preventable) and falls respectively. Most CQT Student AllInj and PrevInj were caused by running (55.1% of AllInj, 100% of which were preventable), followed by causes (e.g. calisthenics during BCT, punching during combatives) and lifting. Most SBT-22 Operator AllInj were caused by lifting (25.0% of AllInj, 100% of which were preventable), followed by running and direct trauma.

The activities during which AllInj occurred for the most common AllInj sub-locations are listed in **Table 13.**

Table 13. AllInj sub-location by activity

AllInj sub-location	SQT	Group 2	CQT	SBT-22
	Activity	Activity	Activity	Activity
Knee			Physical Training: 11 Tactical Training: 3 Recreational Activity: 1	Physical Training: 3 Tactical Training: 3 Recreational Activity: 2 Other*: 3
			Total: 15	**Total: 11**
Lower Leg			Physical Training: 19 Recreational Activity: 1	
			Total: 20	
Ankle	Physical Training: 13 Tactical Training: 6 Recreational Activity: 4	Recreational Activity: 6 Tactical Training: 3 Other*: 5		
	Total: 23	**Total: 14**		
Shoulder	Physical Training: 12 Tactical Training: 8 Recreational Activity: 3	Physical Training: 7 Recreational Activity: 6 Other*: 4	Physical Training: 12 Tactical Training: 2 Other*: 2	Physical Training: 4 Recreational Activity: 2 Other*: 2
	Total: 23	**Total: 17**	**Total: 16**	**Total: 8**
Lumbopelvic Region	Physical Training: 11 Other*: 8	Physical Training: 6 Recreational Activity: 1 Tactical Training: 1		Occupational Tasks: 3 Recreational Activity: 1 Other*: 1
	Total: 19	**Total: 8**		**Total: 5**

*Other: this category represents any activity type with only a single injury or any injury without a specified activity or cause

For SQT Students, weight lifting during physical training was reported as the cause for most shoulder and lumbopelvic region AllInj, while running during physical training was the cause for most ankle AllInj. Most ankle AllInj during tactical training were reported during TAO; most shoulder AllInj during tactical training were reported during combatives. For G2 Operators, most AllInj to the shoulder and lumbopelvic region were attributed to weight lifting during physical training or recreational activities. Of the AllInj reported during tactical training, ankle AllInj were attributed to combatives or bad landings during TAO, while the lumbopelvic AllInj reported during tactical training was the result of a helicopter crash.

For CQT Students, running during physical training or recreational activity was the reported cause for all of the lower leg and most of the knee AllInj. Of the knee injuries that occurred during tactical training, one occurred on an underway, one occurred while running during Small Arms at Camp Pendleton, and one occurred during combatives. All shoulder AllInj attributed to tactical training occurred during combatives, and those reported during physical training occurred either during conditioning (calisthenics) or on the obstacle course. For SBT-22 Operators, weight lifting during physical training or recreational activities was the most common cause of shoulder AllInj. AllInj to the lumbopelvic region caused by occupational tasks were all attributed to lifting or loading weapons and ammunition. Knee AllInj during physical training occurred playing speedball or weight lifting, and knee

AllInj during tactical training resulted from a loss of balance or slipping on spent brass while on the boats.

Injury Types

Injury type for AllInj and PrevInj are presented in **Table 14** and **15** respectively.

Table 14. AllInj type

AllInj type	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Bursitis	0	0.0	1	1.0	2	2.0	1	2.8
Chondromalacia/patellofemoral pain	1	0.7	0	0.0	0	0.0	1	2.8
Degenerative joint disease	0	0.0	1	1.0	0	0.0	0	0.0
Disc injury	0	0.0	2	2.1	0	0.0	1	2.8
Dislocation	1	0.7	3	3.1	1	1.0	4	11.1
Fracture	16	11.7	16	16.7	4	4.1	2	5.6
Impingement	2	1.5	2	2.1	1	1.0	2	5.6
Inflammation	6	4.4	3	3.1	11	11.2	1	2.8
Labral tear	1	0.7	2	2.1	0	0.0	1	2.8
Meniscal	4	2.9	2	2.1	0	0.0	1	2.8
Nerve	7	5.1	2	2.1	0	0.0	0	0.0
Pain / spasm / ache	18	13.1	6	6.3	19	19.4	6	16.7
Periostitis	2	1.5	0	0.0	3	3.1	0	0.0
Sprain	31	22.6	13	13.5	14	14.3	7	19.4
Strain	21	15.3	21	21.9	9	9.2	4	11.1
Stress fracture	4	2.9	0	0.0	11	11.2	1	2.8
Subluxation	3	2.2	0	0.0	2	2.0	0	0.0
Tendonitis / tenosynovitis / tendinopathy	12	8.8	8	8.3	17	17.3	3	8.3
Other	6	4.4	4	4.2	2	2.0	1	2.8
Unknown	2	1.5	10	10.4	2	2.0	0	0.0
Total	**137**		**96**		**98**		**36**	

Table 15. PrevInj type

PrevInj type	SQT		Group 2		CQT		SBT-22	
	n	%	n	%	n	%	n	%
Bursitis	0	0.0	0	0.0	2	2.7	0	0.0
Chondromalacia/patellofemoral pain	1	1.3	0	0.0	0	0.0	1	4.5
Degenerative joint disease	0	0.0	0	0.0	0	0.0	0	0.0
Disc injury	0	0.0	0	0.0	0	0.0	0	0.0
Dislocation	0	0.0	0	0.0	1	1.4	1	4.5
Fracture	1	1.3	0	0.0	0	0.0	0	0.0
Impingement	2	2.6	1	2.6	1	1.4	2	9.1
Inflammation	6	7.7	2	5.3	11	15.1	1	4.5
Labral tear	0	0.0	2	5.3	0	0.0	1	4.5
Meniscal	0	0.0	1	2.6	0	0.0	1	4.5
Nerve	5	6.4	0	0.0	0	0.0	0	0.0
Pain / spasm / ache	9	11.5	5	13.2	9	12.3	6	27.3
Periostitis	2	2.6	0	0.0	3	4.1	0	0.0
Sprain	14	17.9	4	10.5	7	9.6	1	4.5
Strain	20	25.6	15	39.5	6	8.2	4	18.2
Stress fracture	4	5.1	0	0.0	11	15.1	1	4.5
Subluxation	1	1.3	0	0.0	1	1.4	0	0.0
Tendonitis / tenosynovitis / tendinopathy	11	14.1	7	18.4	17	23.3	3	13.6
Other	2	2.6	0	0.0	2	2.7	0	0.0
Unknown	0	0.0	1	2.6	2	2.7	0	0.0
Total	**78**		**38**		**73**		**22**	

The top three AllInj types for SQT Students were: sprains (22.6%), strains (15.3%), and pain/spasm/ache (13.1%). Strains accounted for the highest percentage of PrevInj (25.6%), followed by sprains (17.9%) and tendinopathies (14.1%). The top three AllInj types for G2 Operators were: strains (21.9%), fractures (16.7%), and sprains (13.5%). Strains accounted for the highest percentage of PrevInj (39.5%), followed by tendinopathies (18.4%) and pain/spasm/ache (13.2%).

The top three AllInj types for CQT Students were: pain/spasm/ache (19.4%), tendinopathies (17.3%), and sprains (14.3%). This group reported a significant number of stress fractures (11.2% of AllInj), all of which were classified as preventable. Tendinopathies accounted for the highest percentage of PrevInj (23.3%), followed by inflammation and stress fractures (both 15.1%). The top three AllInj types for SBT-22 Operators were sprains (19.4%), pain/spasm/ache (16.7%), and strains and dislocations (11.1% each). Pain/spasm/ache accounted for the highest percentage of PrevInj (27.3%), followed by strains (18.2%) and tendinopathies (13.6%).

The AllInj types for the most common AllInj sub-locations are listed in **Table 16**.

Table 16. AllInj type by sub-location

AllInj sub-location	SQT	Group 2	CQT	SBT-22
	AllInj Type	**AllInj Type**	**AllInj Type**	**AllInj Type**
Knee			Tendiopathy: 4 Pain/spasm/ache: 4 Sprain: 2 Bursitis: 2 Other*: 3 **Total: 15**	Sprain: 3 Patellar disloaction: 3 Pain/spasm/ache: 2 Other*: 3 **Total: 11**
Lower Leg			"Shin splints"ǂ: 13 Stress fracture: 7 **Total: 20**	
Ankle	Sprain: 19 Tendinopathy: 2 Other*: 2 **Total: 23**	Sprain: 8 Fracture: 2 Tendinopathy: 1 Other*: 3 **Total: 14**		
Shoulder	Pain/spasm/ache: 5 Sprain or Strain: 4 Tendinopthy: 3 Dislocation/subluxation: 3 Nerve: 3 Impingement: 2 Other*: 3 **Total: 23**	Strain: 4 Dislocation/subluxation: 2 Labral tear: 2 Pain/spasm/ache: 2 Other*: 7 **Total: 17**	Strain: 6 Dislocation/subluxation: 3 Pain/spasm/ache: 3 Tendiopathy: 2 Other:* 2 **Total: 16**	Labral tear: 2 Impingement: 2 Pain/spasm/ache: 2 Other*: 2 **Total: 8**
Lumbopelvic Region	Strain: 7 Pain/spasm/ache: 6 Sprain: 2 Nerve: 2 Other*: 2 **Total: 19**	Strain: 5 Pain/spasm/ache: 2 Fracture: 1 **Total: 8**		Strain: 2 Pain/spasm/ache: 2 Disc injury: 1 **Total: 5**

*Other: this category represents any activity type with only a single injury or any injury without a specified activity or cause
ǂ"Shin splints": combined inflammation, periostitis, and pan/spasm/ache injury types based on injury description comments

For the three most common AllInj sub-locations for SQT Students, ankle sprains, shoulder pain/spasm/ache, and lumbopelvic strains were the most common AllInj types. For the three most common AllInj sub-locations for G2 Operators, shoulder strains, ankle sprains, and lumbopelvic strains were the most common AllInj types. For the three most common AllInj sub-locations for CQT Students, shoulder strains, knee tendinopathy and pain/spasm/ache, and lower leg “shin splints” were the most common AllInj types. For the three most common AllInj sub-locations for SBT-22 Operators, knee sprains and patellar dislocations, shoulder labral tears, impingement, and pain/spasm ache, and lumbopelvic strains and pain/spasm/ache were the most common AllInj types.

Injury Classification

The classification of AllInj and PrevInj based on onset is presented in **Tables 17**, **18** and **19**.

Table 17. Onset (acute vs. chronic)

	SQT		Group 2		CQT		SBT-22	
	AllInj	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**
Acute	105/137	52/78	72/96	25/38	75/98	54/73	30/36	19/22
	76.6%	66.7%	75.0%	65.8%	76.5%	74.0%	83.3%	86.4%
Chronic	28/137	25/78	7/96	5/38	21/98	17/73	4/36	3/22
	20.4%	32.1%	7.3%	13.2%	21.4%	23.3%	11.1%	13.6%
Unknown	4/137	1/78	17/96	8/38	2/98	2/73	2/36	0/22
	2.9%	1.3%	17.7%	21.1%	2.0%	2.7%	5.6%	0.0%

Table 18. Onset (overuse vs. non-overuse)

	SQT		Group 2		CQT		SBT-22	
	AllInj	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**
Overuse	64/137	53/78	21/96	15/38	63/98	60/73	15/36	14/22
	46.7%	67.9%	21.9%	39.5%	64.3%	82.2%	41.7%	63.6%
Non-Overuse	69/137	24/78	25/96	10/38	34/98	13/73	20/36	7/22
	50.4%	30.8%	26.0%	26.3%	34.7%	17.8%	55.6%	31.8%
Unknown	4/137	1/78	21/96	13/38	1/98	0/73	1/36	1/22
	2.9%	1.3%	21.9%	34.2%	1.0%	0.0%	2.8%	4.5%

Table 19: Onset (contact vs. non-contact)

	SQT		Group 2		CQT		SBT-22	
	AllInj	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**
Contact	15/137	0/78	21/96	0/38	10/98	0/73	5/36	0/22
	10.9%	0.0%	21.9%	0.0%	10.2%	0.0%	13.9%	0.0%
Non-contact	117/137	77/78	54/96	37/38	86/98	72/73	29/36	22/22
	85.4%	98.7%	56.3%	97.4%	87.8%	98.6%	80.6%	100.0%
Unknown	5/137	1/78	21/96	1/38	2/99	1/73	2/36	0/22
	3.6%	1.3%	21.9%	2.6%	2.0%	1.4%	5.6%	0.0%

Most AllInj and PrevInj had an acute onset for all four groups. Most PrevInj were categorized as overuse in all four groups. Most AllInj and PrevInj were classified as non-contact in all four groups. For the three most common AllInj sub-locations for SQT Students, most ankle AllInj had an acute onset (91.3%) and were not classified as overuse (78.2%), most shoulder AllInj had an acute onset (73.9%) and were overuse (60.9%), and most lumbopelvic AllInj had an acute onset (89.5%) and were evenly split between overuse and non-overuse (47.4% each). For the three most common AllInj sub-locations

for G2 Operators, most shoulder (64.7%), ankle (92.9%), and lumbopelvic AllInj (75.0%) had an acute onset. Most G2 Operators did not report whether or not their injuries were overuse.

For the three most common AllInj sub-locations for CQT Students, lower leg AllInj had an acute onset (75.0%) and were all overuse (100.0%), most shoulder AllInj had an acute onset (68.8%) and were not overuse (43.8%), and most knee AllInj had an acute onset (80.0%) and were overuse (73.3%). For the three most common AllInj sub-locations for SBT-22 Operators, most knee AllInj had an acute onset (63.6%) and were not overuse (63.6%), most shoulder AllInj were acute (75%) and evenly split between overuse and non-overuse (50% each), and all lumbopelvic AllInj had an acute onset (100%) and were overuse (60%).

Care, Treatment, and Effect on Training

Time lost due to AllInj and PrevInj is presented in **Table 20**. Data for diagnostic testing and treatment are presented in **Table 21** for AllInj and PrevInj. The number of hospital visits and visits to medical professionals per AllInj and PrevInj are presented in **Table 22**.

Table 20. Time lost due to AllInj and PrevInj

	SQT		Group 2		CQT		SBT-22	
	AllInj	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**
None	21/65	15/49	31/96	13/38	47/96	34/72	13/36	9/22
	32.3%	30.6%	32.3%	34.2%	49.0%	47.2%	36.1%	40.9%
1-6 days	4/65	4/49	0/96	0/38	5/96	1/72	1/36	1/22
	6.2%	8.2%	0.0%	0.0%	5.2%	1.4%	2.8%	4.5%
7-14 days	5/65	4/49	8/96	4/38	10/96	9/72	7/36	6/22
	7.7%	8.3%	8.3%	10.5%	10.4%	12.5%	19.4%	27.3%
15-21 days	1/65	1/49	1/96	0/38	5/96	3/72	4/36	1/22
	1.5%	2.0%	1.0%	0.0%	5.2%	4.2%	11.1%	4.5%
1-2 months	5/65	3/49	14/96	5/38	2/96	1/72	6/36	3/22
	7.7%	6.1%	14.6%	13.2%	2.1%	1.4%	16.7%	13.6%
≥3 months	3/65	3/49	7/96	4/38	11/96	10/72	4/36	2/22
	4.6%	6.1%	7.3%	10.5%	11.5%	13.9%	11.1%	9.1%
Unknown	26/65	19/49	35/96	12/38	16/96	14/72	1/36	0/22
	40.0%	38.8%	36.5%	31.6%	16.7%	19.4%	2.8%	0.0%

Note: Data were available for 65 SQT injuries (49 of which were preventable), 96 CQT injuries (72 of which were preventable), and all G2 and SBT-22 injuries

Table 21. Diagnostics, treatment, and medical professional visits

	SQT		Group 2		CQT		SBT-22	
	AllInj	PrevInj	AllInj	PrevInj	AllInj	PrevInj	AllInj	PrevInj
MRI	4/65 6.2%	4/49 8.2%	3/96 3.1%	2/38 5.3%	2/96 2.1%	2/72 2.8%	7/36 19.4%	3/22 13.6%
X-Ray	9/65 13.8%	5/49 10.2%	12/96 12.5%	2/38 5.3%	21/96 21.9%	14/72 19.4%	11/36 30.6%	4/22 18.2%
Ambulatory Aid	0/65 0.0%	0/49 0.0%	0/96 0.0%	0/38 0.0%	1/96 1.0%	1/72 1.4%	0/36 0.0%	0/22 0.0%
Brace/Cast/ Immobilization	0/65 0.0%	0/49 0.0%	1/96 1.0%	0/38 0.0%	4/96 4.2%	2/72 2.8%	0/36 0.0%	0/22 0.0%
Ice	29/65 44.6%	23/49 46.9%	21/96 21.9%	14/38 36.8%	41/96 42.7%	37/72 51.4%	27/36 75.0%	18/22 81.8%
Massage	5/65 7.7%	5/49 10.2%	3/96 3.1%	2/38 5.3%	3/96 3.1%	3/72 4.2%	7/36 19.4%	5/22 22.7%
Pain medication	21/65 32.3%	19/49 38.8%	16/96 16.7%	8/38 21.1%	31/96 32.3%	27/72 37.5%	18/36 50.0%	10/22 45.5%
Therapeutic Modalities	0/65 0.0%	0/49 0.0%	1/96 1.0%	1/38 2.6%	2/96 2.1%	2/72 2.8%	0/36 0.0%	0/22 0.0%
Physical Therapy/ Rehab Exercises	14/65 21.5%	13/49 26.5%	19/96 19.8%	13/38 34.2%	26/96 27.1%	22/72 30.6%	21/36 58.3%	12/22 54.5%
Rest	33/65 50.8%	24/49 49.0%	19/96 19.8%	11/38 28.9%	48/96 50.0%	38/72 52.8%	24/36 66.7%	16/22 72.7%
Surgery	1/65 1.5%	1/49 2.0%	8/96 8.3%	3/38 7.9%	2/96 2.1%	1/72 1.4%	3/36 8.3%	1/22 4.5%
Athletic Trainer	1/65 1.5%	1/49 2.0%	2/96 2.1%	1/38 2.6%	12/96 12.5%	12/72 16.7%	2/36 5.6%	2/22 9.1%
Doctor	11/65 16.9%	8/49 16.3%	23/96 24.0%	6/38 15.8%	24/96 25.0%	17/72 23.6%	17/36 47.2%	9/22 40.9%
Medic/Corpsman	16/65 24.6%	11/49 22.4%	7/96 7.3%	6/38 15.8%	42/96 43.8%	35/72 48.6%	13/36 36.1%	7/22 31.8%
Physical Therapist	12/65 18.5%	11/49 22.4%	11/96 11.5%	7/38 18.4%	10/96 10.4%	9/72 12.5%	20/36 55.6%	12/22 54.5%
Physician's Assistant	1/65 1.5%	0/49 0.0%	1/96 1.0%	1/38 2.6%	0/96 0.0%	0/72 0.0%	1/36 2.8%	1/22 4.5%
Chiropractor	1/65 1.5%	1/49 2.0%	2/96 2.1%	1/38 2.6%	1/96 1.0%	0/72 0.0%	0/36 0.0%	0/22 0.0%
Massage Therapist	2/65 3.1%	2/49 4.1%	0/96 0.0%	0/38 0.0%	0/96 0.0%	0/72 0.0%	0/36 0.0%	0/22 0.0%

Note: Data were available for 65 SQT injuries (49 of which were preventable), 96 CQT injuries (72 of which were preventable), and all G2 and SBT-22 injuries

Table 22. Number of hospital and medical professional visits

	SQT		Group 2		CQT		SBT-22	
	AllInj	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**	**AllInj**	**PrevInj**
Hospital visits	0 visits: 29/65 44.6%	0 visits: 21/49 42.9%	0 visits: 31/96 32.3%	0 visits: 13/38 34.2%	0 visits: 50/96 52.1%	0 visits: 38/72 52.8%	0 visits: 23/36 63.9%	0 visits: 15/22 68.2%
	1 visit: 1/65 1.5%	1 visit: 1/49 2.0%	5-15 visits: 2/96 2.1%	5-15 visits: 0/38 0.0%	1 visit: 1/96 1.0%	1 visit: 1/72 1.4%	1 visit: 1/36 2.8%	1 visit: 1/22 4.5%
	Unknown: 35/65 53.8%	Unknown: 27/49 55.1%	Unknown: 63/96 65.6%	Unknown: 25/38 65.8%	Unknown: 45/96 46.9%	Unknown: 33/72 45.8%	Unknown: 12/36 33.3%	Unknown: 6/22 27.3%
Medical professional visits	0 visits: 0/65 0.0%	0 visits: 0/49 0.0%	0 visits: 5/96 5.2%	0 visits: 3/38 7.9%	0 visits: 0/98 0.0%	0 visits: 0/72 0.0%	0 visits: 0/36 0.0%	0 visits: 0/21 0.0%
	1-4 visits: 25/65 38.5%	1-4 visits: 17/49 34.7%	1-4 visits: 18/96 18.8%	1-4 visits: 8/38 21.1%	1-4 visits: 26/96 27.1%	1-4 visits: 18/72 25.0%	1-4 visits: 15/36 41.7%	1-4 visits: 11/22 50.0%
	7-80 visits: 8/65 12.3%	7-80 visits: 8/49 16.3%	8-50 visits: 13/96 13.5%	8-50 visits: 6/38 15.8%	5-220 visits: 28/96 29.2%	5-220 visits: 24/72 33.3%	5-220 visits: 12/36 33.3%	5-220 visits: 5/22 22.7%
	Unknown: 32/65 49.2%	Unknown: 24/49 49.0%	Unknown: 60/96 62.5%	Unknown: 21/38 55.3%	Unknown: 42/96 43.8%	Unknown: 30/72 41.7%	Unknown: 9/36 25.0%	Unknown: 6/22 27.3%

Note: Data were available for 65 SQT injuries (49 of which were preventable), 96 CQT injuries (72 of which were preventable), and all G2 and SBT-22 injuries

Of those injuries requiring diagnostic imaging, x-rays were the most common, with AllInj requiring slightly more x-rays than PrevInj for all groups. MRIs were the second most common imaging, with SBT-22 Operators and SQT Students undergoing more MRIs than other groups. Greater than 50% of AllInj and PrevInj required rest in all groups, except G2 Operators, who only rested approximately 20 to 30% of AllInj and PrevInj. SBT-22 Operators performed physical therapy or rehabilitation exercises for more than half of AllInj and PrevInj. Ice, pain medication, and physical therapy were the most common AllInj treatments for all groups. Both SQT and CQT Students had fewer surgeries than G2 or SBT-22 Operators, who both required surgery for approximately 8% of AllInj.

Of the AllInj treated by a medical professional, most AllInj were treated by a medic/corpsman, doctor, or physical therapist. Very few AllInj required hospitalization (2.8% or less for all groups AllInj, and 4.5% or less for all groups PrevInj). Most subjects reported seeing a medical professional for one to four visits per AllInj, except for CQT Students, where the majority of AllInj required five or more visits. Most AllInj did not result in any time lost.

Self-Reported Injuries Related to Equipment, Fatigue, Hydration, and Fueling Status

Each subject was asked about certain circumstances surrounding injury that occurred during physical training. They were asked if at the time of injury they were fatigued, adequately hydrated, had an appropriate meal, carrying a load, and if any of these circumstances may have contributed to the injury. The results of these questions are listed in **Table 23**.

Table 23. Physical training related AllInj and their association with fatigue, hydration, meal, and load

		SQT		Group 2		CQT		SBT-22	
		AllInj	PrevInj	AllInj	PrevInj	AllInj	PrevInj	AllInj	PrevInj
Self-reported fatigue/over exertion prior to injury?	Yes	44/75	34/56	2/23	2/18	28/76	22/62	0/12	0/11
		58.7%	60.7%	8.7%	11.1%	36.8%	35.5%	0.0%	0.0%
	No	29/75	21/56	15/23	13/18	48/76	40/62	12/12	11/11
		38.7%	37.5%	65.2%	72.2%	63.2%	64.5%	100.0%	100.0%
	Unknown	2/75	1/56	6/23	3/18	0/76	0/62	0/12	0/11
		2.7%	1.8%	26.1%	16.7%	0.0%	0.0%	0.0%	0.0%
Adequate hydration prior to injury?	Yes	61/75	44/56	17/23	15/18	73/76	59/62	12/12	11/11
		81.3%	78.6%	73.9%	83.3%	96.1%	95.2%	100.0%	100.0%
	No	12/75	11/56	0/23	0/18	1/76	1/62	0/12	0/11
		16.0%	19.6%	0.0%	0.0%	1.3%	1.6%	0.0%	0.0%
	Unknown	2/75	1/56	6/23	3/18	2/76	2/62	0/12	0/11
		2.7%	1.8%	26.1%	16.7%	2.6%	3.2%	0.0%	0.0%
Appropriate meal prior to injury?	Yes	67/75	49/56	16/23	14/18	75/76	61/62	12/12	11/11
		89.3%	87.5%	69.6%	77.8%	98.7%	98.4%	100.0%	100.0%
	No	5/75	5/56	1/23	1/18	1/76	1/62	0/12	0/11
		6.7%	8.9%	4.3%	5.6%	1.3%	1.6%	0.0%	0.0%
	Unknown	3/75	2/56	6/23	3/18	0/76	0/62	0/12	0/11
		4.0%	3.6%	26.1%	16.7%	0.0%	0.0%	0.0%	0.0%
Carrying load when injured?	Yes	25/75	20/56	4/23	4/18	7/76	7/62	2/12	1/11
		33.3%	35.7%	17.4%	22.2%	9.2%	11.3%	16.7%	9.1%
	No	45/75	33/56	13/23	11/18	64/76	50/62	10/12	10/11
		60.0%	58.9%	56.5%	61.1%	84.2%	80.6%	83.3%	90.9%
	Unknown	5/75	3/56	6/23	3/18	5/76	5/62	0/12	0/11
		6.7%	5.4%	26.1%	16.7%	6.6%	8.1%	0.0%	0.0%

SQT Students reported fatigue contributed to approximately 60% of AllInj and PrevInj during physical training, approximately twice as much as CQT Students, and six times as much as the G2 Operators. SBT-22 Operators reported no fatigue related injuries during physical training. The majority of Students and Operators reported adequate hydration and appropriate meals prior to AllInj during physical training. SQT Students reported that they were carrying a load during physical training when the AllInj occurred in just over 30% of AllInj and PrevInj, more than the approximately 20% reported by G2 Operators and approximately 10% reported by CQT Students and SBT-22 Operators.

Chapter 4. Discussion

The objective of this analysis was to describe the scope and magnitude of musculoskeletal injuries (AllInj) specific to the NSW Student and Operator populations based on self-reported epidemiological data as collected by University of Pittsburgh faculty. These data combined with task and demand analyses and the laboratory testing of Students and Operators provides evidence for modifications or augmentation of current physical training to ensure that preparation meets performance and injury prevention requirements. Overall, a majority of preventable musculoskeletal injuries (PrevInj) occurred during physical training. This implies that potential prevention strategies should focus on modifying physical training, especially evolutions involving running or lifting. The majority of individual Students and Operators (772 of 1,061 surveyed) did not report an injury during the one-year prior to survey. This analysis describes 367 AllInj reported by 289 Students and Operators.

Injury Frequency and Incidence

The AllInj frequency was 38.7 injuries per 100 SQT Students per year, 25.4 injuries per 100 G2 Operators per year, 52.4 injuries per 100 CQT Students per year, and 25.4 injuries per 100 SBT-22 Operators per year. The AllInj incidence was 30.5 injured SQT Students per 100 SQT Students per year, 22.0 injured G2 Operators per 100 G2 Operators per year, 37.4 injured CQT Students per 100 CQT Students per year, and 19.7 injured SBT-22 Operators per 100 SBT-22 Operators per year. AllInj frequency and incidence in both SQT and CQT Students were much higher than in the Operator population, which is consistent with previous reports and is likely due to extreme physical activity during these training pipelines.[25, 37] AllInj frequency among Students was similar to that reported by Hollingsworth, et al. in Marine Corps Special Operations Command (MARSOC) Operators during pre-deployment training (approximately 47 injuries per 100 MARSOC Operators per year).[23] There was individual variability among G2 and SBT-22 Operators in phase of physical and tactical training, depending on deployment cycles and mission types, which may explain the higher volume of AllInj reported among Students and MARSOC Operators. Certain training evolutions are associated with specific injury patterns. For AllInj data by training phase for SQT and CQT Students, see **Appendix A**.

The AllInj frequency and incidence among G2 and SBT-22 Operators are slightly less than observed in Air Force Special Operations Command (AFSOC) Special Tactics Squadron (STS) Operators (31.6 injuries per 100 STS Operators per year and 24.0 injured STS Operators per 100 STS Operators per year),[38] and similar to a group of United States Army Special Operations Command (USASOC) Special Forces Operators (24.5 injuries per 100 SFO per year and 20.8 injured SFO per 100 SFO per year were injured).[22] Similar data from general-purpose forces (GPF) collected by the University of Pittsburgh as part of our research with the 101st Airborne Division (Air Assault) demonstrated lower injury frequency and incidence (24.0 injuries per 100 Soldiers per year and 14.0 injured Soldiers per 100 Soldiers per year respectively) compared to the current NSW cohort. These data indicate that NSW Students suffer a greater number of injuries and a greater number of Students are injured compared to G2, SBT-22, AFSOC STS, USASOC SFO, and GPF.

Anatomic Location and Sub-location

Overall, the major anatomic locations injured among SQT Students and G2 Operators were the lower extremity, upper extremity, and spine, with the major concentration of AllInj to the shoulder, ankle, and lumbopelvic region. The major anatomic locations injured among CQT Students and SBT-22 Operators were also the lower extremity, upper extremity, and spine, however AllInj were concentrated in the shoulder, knee, lower leg (CQT Students), and lumbopelvic region (SBT-22 Operators). This is similar to that reported in USASOC SFO,[22] MARSOC Operators,[23] and our GPF data, who all reported primarily lower extremity injuries, and medical chart review of G2 Operators and Support Personnel[25]

who reported primarily back and knee injuries.

Activities When Injury Occurred and Injury Causes

Physical training accounted for the highest percentage of AllInj for all groups except G2 Operators (SQT: 54.7%, CQT: 77.6%, and SBT-22: 33.3%), and the highest percentage of PrevInj for all groups (SQT: 71.8%, G2: 47.4%, CQT: 84.9%, and SBT-22: 50.0%). A complete list of these injuries is included in **Appendix B (Physical Training Injuries)**. Military epidemiological studies consistently report that most injuries occur during physical training,[3] and the Operator data in this report is consistent with the injuries reported in GPF (48.5%), USASOC SFO (46.2%),[22] and AFSOC STS (50.0%). Physical training accounted for a much higher percentage of AllInj in Students than in any group of Operators, most likely due to the volume of physical training in both CQT and SQT pipelines.

Running and lifting were the most common causes of PrevInj in all groups (running: SQT: 43.6%, G2: 21.1%, CQT: 74.0%, SBT-22: 27.3%; lifting: SQT: 30.8%, G2: 42.1%, CQT: 11.0%, SBT-22: 40.9%). Running was the most common cause of AllInj and PrevInj in Students, while more injuries were attributed to lifting in both Operator groups. It is likely that SQT and CQT Students have a higher running volume and spend less time weight lifting than individuals at NSW Operational commands. Running was the most common cause of injury in USASOC SFO (30.0% of preventable injuries) and GPF personnel (34.3% of all injuries), while AFSOC STS reported most preventable injuries (60.0%) during weight lifting. Based on these data, it is clear that running and lifting during physical training results in a significant number of injuries across the Special Operations community.

Injury Types and Onset

Sprains and strains were the most common type of AllInj and PrevInj among SQT Students and G2 Operators; pain/spasm/ache was the most common AllInj type among CQT Students and SBT-22 Operators, with stress fractures as the most common PrevInj among CQT Students. When all AllInj reported after enlistment are considered, stress fractures are the most common type of AllInj and the second most common type of PrevInj in both SQT and CQT Students (see **Appendix A** for training pipeline data). This is most likely due to the volume of running and physical activity required during the physical training phases of the pipelines (BUD/S 1st phase and BCT), and it is important to consider the differences between physical training at operational commands and at the school houses to understand the differences in reported injuries. The AllInj types reported by both G2 and SBT-22 Operators are similar to those reported in AFSOC STS (pain/spasm/ache, followed by sprain and strain) and USASOC SFO and GPF (sprains were the most common cause of injury).

The majority of AllInj and PrevInj in this study had an acute onset, which is in accordance with previous reports. Most SQT Student, and G2 and SBT-22 Operator AllInj were not overuse injuries, while the majority of CQT Student AllInj were overuse. For the purpose of this study, an overuse injury was defined as an injury caused by excessive or unaccustomed activity and relieved by rest. Since the training pipeline for SWCCs is shorter than for SEALs, many of the CQT Students surveyed for this study had completed BCT within one-year of the survey date, whereas many SQT Students were more than one-year removed from the complete of BUD/S 1st Phase. When all AllInj since date of enlistment were considered, most AllInj reported during BUD/S, BCT, and physical training during SQT and CQT have an acute onset and are considered overuse injuries. The volume of exercise over short periods of time during these training evolutions result in the rapid (acute) onset of these overuse injuries. This is similar to Linenger et al.'s medical chart review of SEAL trainees, where overuse injuries accounted for greater than 90% of all injuries.[37] G2 and SBT-22 Operators may be able to manage their training volume and rest cycles to avoid overuse injuries. However it is important to note that 39.5% (G2) and 63.6% (SBT-22) PrevInj were overuse, indicating that educational interventions regarding training and rest cycles could decrease injury rates in these groups.

Injury Treatment and Time Lost

Of the injuries treated by a medical professional, most AllInj were treated by medic/corpsman, doctor, or a physical therapist. Most AllInj did not result in any time lost. Of AllInj with associated time lost, most resulted in less than three weeks of lost training days, except for G2 Operators and CQT Students. G2 Operators also reported the most surgeries associated with AllInj and CQT Students reported more lower extremity stress fractures than any other group (during this one-year reporting period), which is the likely reason for the large loss of training days in these groups. See **Appendix A** for complete SQT and CQT Student data, including time lost for rolls during the training pipelines.

Considerations and Limitations

This investigation is part of comprehensive laboratory testing. Therefore, subjects must have met inclusion criteria, which may have potentially excluded Students and Operators who suffered serious injuries. In addition, those who suffer serious musculoskeletal injuries are likely to have been rolled or dropped from training and may have been assigned to different units or services outside of the Special Operations community. That would likely mean that this study includes only Students and Operators who have completed training, missions, and/or deployments without major injuries. This may result in underestimation of actual injury counts. Collecting injury data using self-report methods is a valid and accepted practice in injury epidemiological research,[39-41] and limiting the recall period to one year should limit the effect of recall bias.[32-34] Past research has shown that individuals in overall good health, younger age, and with higher education accurately report injuries,[42, 43] particularly those perceived as more traumatic (e.g. fractures or those sustained during motor vehicle accidents).[42, 44, 45] The self-report method may also have captured injuries not reported to medical personnel (to avoid being rolled or dropped from training, specialized schools, or work-ups), which would have been missed in medical record reviews. The variability of injury frequency, incidence, anatomical location, type, and mechanism among studies may be explained by the variance in injury data collection methods utilized. The USASOC, AFSOC, and GPF data referenced in this study were collected by University of Pittsburgh faculty using similar methods and operational definitions to those used in the present report.

Chapter 5. Recommendations

Students and Operators participate in rigorous physical training to prepare them for demands of tactical training and deployment. Musculoskeletal injuries are an unfortunate consequence of this training. Many injuries are potentially preventable through evidence-based interventions that include activity/exercise modification and educational programs. The data included in this technical report indicates that Students and Operators suffer a wide distribution of injuries based on anatomical location, most commonly to the shoulder, lumbopelvic region, and lower extremity. Injury prevention strategies can include appropriate exercises and activities for each of these joints/anatomical regions and should include strengthening, flexibility, neuromuscular control, postural stability, and functional exercises/activities, in addition to education regarding rest and recovery strategies. A large number of injuries (particularly to the lower extremity and shoulder) occur during physical training while individuals are running or lifting weights. Injury prevention relative to physical training should focus on a reduction of these injuries, which may require modifications to technique (or monitoring of technique), examination of volume of training, and/or substitution of alternative exercises/activities.

Appendix A. SQT and CQT Student Injuries by Training Phase

This appendix contains injuries reported by Students in NSW training pipelines as requested by NSW Center and BUD/S Medical personnel.

Training pipelines for prospective SEAL and SWCC Operators are among the most physically and mentally demanding in the world.[37] Candidates for SEAL and SWCC begin training for their respective communities with three weeks of Basic Underwater Demolition/SEAL (BUD/S) Orientation (BO). Candidates for the SEAL community complete BUD/S: First Phase (seven weeks of basic conditioning including Hell Week), Second Phase (seven weeks of combat swimming and diving), and Third Phase (seven weeks of land warfare training). Once Students graduate from BUD/S, they enter 31 weeks of tactical training in the SEAL Qualification Training (SQT) pipeline. From BO, SWCC candidates complete eight weeks of Basic Crewman Training (BCT), a basic conditioning phase that includes The Tour. Students complete survival training, and then enter 14 weeks of tactical training in the Crewman Qualification Training (CQT) pipeline. After graduation, Operators from both programs join operational teams and begin their careers with additional training, schools, work-ups, and deployments.

This appendix includes all self-reported injuries by the Student physical and tactical training since their date of enlistment (greater than one-year prior to the date of survey to accommodate the length of the training pipeline). The methods and operational definitions used are otherwise identical to those described in **Chapter 2 (Methods)**. The AllInj reported in this manuscript refer to all musculoskeletal injuries reported by Students since their date of enlistment; PrevInj refer to the subset of reported AllInj that have been classified as preventable.

Demographic data for all participants are presented in **Table 24**; the last phase of training each Student completed prior to survey date is presented in **Table 25**. The number and type of rolls reported by Students are presented in **Table 26** and **27**, along with mean time (in weeks) for each roll.

Table 24. SQT and CQT Student demographics

	SQT	CQT
N	354	187
Age (years)	24.3 ± 2.7	22.8 ± 3.2
Height (inches)	70.6 ± 2.6	70.1 ± 2.7
Weight (pounds)	187.2 ± 18.6	180.4 ± 18.3
Years Active*	2.1 ± 1.6	1.2 ± 1.2

Age, height, weight, and years active reported as mean ± standard deviation

*years of active duty (years active) were calculated for 347 SQT Students and 162 CQT Students. Individuals reporting <1yr of active duty were calculated as having 6 months of service;

Table 25. Last phase of training completed

BUD/S or SQT Phase	n
Admin	10
BUD/S	14
Comms	4
CSC	2
Graduation	130
Kodiak	8
Language School	12
Land Warfare Niland	9
MAROPS	21
Medical	15
ADVENT LADEN	1
Combatives	5
SERE	19
PME	34
PRODEV	2
TAO Military Free Fall	28
TAO Static Line	15
TAP Assessment	16
Not reported	9
Total	**354**

BCT or CQT Phase	n
ADVENT LADEN	5
BCT	4
Combatives	3
Comms	6
Graduation	23
Language School	8
MED/CBR	11
SERE	85
Heavy Weapons	9
Seamanship	13
Navigation	14
Not reported	6
Total	**187**

Table 26. Number and type of rolls

SQT	n	Time	SD
Total	254	9.3	8.2
Injury	127	12.1	8.9
Performance	114	6.0	5.3
Other	13	11.2	11.3

CQT	n	Time	SD
Total	86	10.1	9.9
Injury	18	17.4	17.6
Performance	65	8.2	5.4
Other	3	8	4

*Time represents the mean time in weeks Students reported being rolled

Table 27. Number and type of rolls by training phase

SQT Phase	Total	Time	Injury	Time	Performance	Time	Other	Time
BO	1	24.0	1	24.0	0	0.0	0	0.0
BUD/S 1st Phase	108	10.6	82	11.6	25	5.8	1	44.0
BUD/S 2nd Phase	69	8.4	30	12.3	39	5.4	0	0.0
BUD/S 3rd Phase	29	5.8	5	6.7	20	5.9	4	4.0
Comms	1	16.0	1	16.0	0	0.0	0	0.0
CQC La Posta	26	8.8	2	16.0	22	7.5	2	16.0
CSC	2	3.5	0	0.0	1	7.0	1	0.0
JOTC	1	7.0	0	0.0	1	7.0	0	0.0
Kodiak	1	10.0	1	10.0	0	0.0	0	0.0
LW Niland	2	10.0	0	0.0	1	4.0	1	16.0
Medical	1	24.0	1	24.0	0	0.0	0	0.0
Combatives	1	8.0	1	8.0	0	0.0	0	0.0
PME	1	24.0	1	24.0	0	0.0	0	0.0
TAO MFF	6	10.5	1	36.0	5	5.4	0	0.0
TAO SL	3	7.0	1	7.0	0	0.0	2	7.0
TAP	2	12.0	0	0.0	0	0.0	2	12.0

CQT Phase	Total	Time	Injury	Time	Performance	Time	Other	Time
3M/Eng	5	13.2	0	0.0	5	13.2	0	0.0
Admin	1	4.0	0	0.0	0	0.0	1	4.0
BCT	47	9.1	14	14.7	32	6.6	1	12.0
Comms	1	5.0	0	0.0	1	5.0	0	0.0
Equip/3M	3	17.3	1	28.0	1	16.0	1	8.0
Graduation	1	16.0	1	16.0	0	0.0	0	0.0
Heavy Weapons	17	8.5	0	0.0	17	8.5	0	0.0
Mission Planning	1	12.0	0	0.0	1	12.0	0	0.0
MED/CBR	3	12.6	0	0.0	3	12.6	0	0.0
Small Arms	6	15.7	2	32.0	4	7.6	0	0.0
Seamanship	1	8.0	0	0.0	1	8.0	0	0.0

*Time represents the mean time in weeks Students reported being rolled

This report describes self-reported AllInj sustained after enlistment reported by 354 SQT Students and187 CQT Students. Surveys were performed between February 2012 and May 2015 and included AllInj reported between July 2002 and April 2015.

Of the 354 SQT Students surveyed, 188 reported being rolled; these 188 SQT Students reported 254 rolls. One hundred and thirty-two SQT Students were rolled once, 46 Students were rolled twice (7 had two injury/illness rolls, 12 had two performance rolls, and 27 had one of each) and 10 were rolled three times (2 had three injury/illness rolls, 8 had both injury/illness and performance rolls). Most rolls occurred during BUD/S (81.1% of all rolls), with the most injury/illness rolls occurring during 1st Phase (39.8% of all BUD/S rolls), with a higher proportion of performance rolls during 2nd Phase and 3rd Phase.

Of the 187 CQT Students surveyed, 74 reported being rolled; these 74 CQT Students reported 86 rolls. Sixty-four CQT Students were rolled once, 8 were rolled twice (all had two performance rolls),

and 2 were rolled three times (1 for both injury/illness and performance, 1 had three performance rolls). Most rolls were for performance (75.6%) of all rolls, with most rolls occurring during BCT and Heavy Weapons evolutions. Most injury/illness rolls occurred during BCT (29.8% of BCT rolls were for injury/illness).

Injury Epidemiology

The number of AllInj and PrevInj reported during physical and tactical training evolutions since date of enlistment are reported in **Table 28**.

Table 28. Total AllInj and PrevInj reported during physical and tactical training

Number of injuries	SQT (AllInj)		SQT (PrevInj)		CQT (AllInj)		CQT (PrevInj)	
	n	%	n	%	n	%	n	%
0	183	51.7	218	61.6	106	56.7	123	65.8
1	103	29.1	94	26.6	53	28.3	43	23.0
2	39	11.0	29	8.2	22	11.8	18	9.6
3	20	5.6	8	2.3	5	2.7	2	1.1
4	4	1.1	3	0.8	0	0.0	0	0.0
5	3	0.8	2	0.6	1	0.5	1	0.5
6	2	0.0	0	0.0	0	0.0	0	0.0
Total	**354**		**354**		**187**		**187**	

One hundred and seventy-one SQT Students reported at least one AllInj since their date of enlistment during physical or tactical training evolutions, for a total of 284 AllInj reported during the training pipeline. Just over half of SQT Students (51.7%) did not report an injury associated with training during the pipeline. A total of 136 SQT Students reported at least one AllInj during training that was classified as preventable, for a total of 198 PrevInj reported during the training pipeline. Overall, 69.7% of the AllInj reported during the training pipeline were classified as preventable.

Eighty-one CQT Students reported at least one AllInj since their date of enlistment during physical or tactical training evolutions, for a total of 116 AllInj reported during the training pipeline. Just over half of CQT Students (56.7%) did not report an injury associated with training during the pipeline. A total of 64 CQT Students reported at least one AllInj during training that was classified as preventable, for a total of 91 PrevInj reported during the training pipeline. Overall, 78.4% of the AllInj reported during the training pipeline were classified as preventable.

The primary anatomic location of AllInj and PrevInj reported during physical and tactical training evolutions are listed in **Table 29**.

Table 29. Anatomic location of AllInj and PrevInj during physical and tactical training

Injury anatomic location	SQT (AllInj)		SQT (PrevInj)		CQT (AllInj)		CQT (PrevInj)	
	n	%	n	%	n	%	n	%
Lower Extremity	173	60.9	145	73.2	85	73.3	76	83.5
Upper Extremity	69	24.3	32	16.2	25	21.6	13	14.3
Spine	30	10.6	20	10.1	6	5.2	2	2.2
Torso	9	3.2	1	0.5	0	0.0	0	0.0
Head/Face	3	4.0	0	0.0	0	0.0	0	0.0
Total	**284**		**198**		**116**		**91**	

The lower extremity was the most common anatomic location of AllInj and PrevInj in both CQT and SQT Students during physical and tactical training evolutions. The majority of these lower extremity AllInj (SQT Students: 73.4%, CQT Students: 92.6%) and PrevInj (SQT Students: 82.8%, CQT Students: 92.1%) were overuse.

The majority of SQT and CQT students did not report wearing orthotics or insoles at the time of their lower extremity or spine injury. Of the 67 SQT Students surveyed about orthotic and insole use, 38 SQT Students reported 67 lower extremity or spine AllInj. Six of the 38 injured SQT Students reported wearing either custom orthotics (2 Students) or Superfeet insoles (4 Students). All but two of the SQT Students had worn these orthotics or insoles for greater than six months prior to injury. The AllInj reported by these 6 SQT Students were: tibial stress fracture, plantar fasciitis, iliotibial band syndrome, "shin splints," and a meniscal tear. All of these AllInj were reported as overuse; 3 of these AllInj were reported during Hell Week, the remaining 3 AllInj were reported during running at BUD/S Prep or BUD/S 1st Phase. Of the 22 CQT Students surveyed about orthotic and insole use, 7 CQT Students reported 10 lower extremity or spine AllInj. Only one of these injured CQT Students reported using custom orthotics (for greater than one year prior to injury), none of the CQT Students reported using insoles. The injured CQT Student reported "shin splints" related to running at BUD/S Prep.

The cause of AllInj and PrevInj reported during physical and tactical training evolutions are listed in **Table 30**.

Table 30. Cause of injuries during physical and tactical training

Cause of injury	SQT (AllInj)		SQT (PrevInj)		CQT (AllInj)		CQT (PrevInj)	
	n	%	n	%	n	%	n	%
Compression from Boating	0	0.0	0	0.0	1	0.9	0	0.0
Climbing	0	0.0	0	0.0	5	4.3	3	3.3
Cutting	1	0.4	1	0.5	0	0.0	0	0.0
Direct Trauma	21	7.4	0	0.0	6	5.2	0	0.0
Fall	11	3.9	0	0.0	4	3.4	0	0.0
Jump	1	0.4	0	0.0	0	0.0	0	0.0
Landing	11	3.9	5	2.5	1	0.9	0	0.0
Lifting	34	12.0	29	14.6	8	6.9	8	8.8
Marching	4	1.4	4	2.0	0	0.0	0	0.0
Planting	3	1.1	2	1.0	1	0.9	1	1.1
Pulling	5	1.8	4	2.0	1	0.9	1	1.1
Running	119	41.9	113	57.1	71	61.2	71	78.0
Twist/Turn/Slip (no fall)	0	0.0	0	0.0	3	2.6	2	2.2
Whiplash	0	0.0	0	0.0	1	0.9	0	0.0
Other	42	14.8	26	13.1	12	10.3	5	5.5
Unknown	32	11.3	14	7.1	2	1.7	0	0.0
Total	**284**		**198**		**116**		**91**	

Most AllInj during physical and tactical training were caused by running (SQT Students: 41.9%, 95.0% of which were classified as preventable; CQT Students: 61.2%, 100% of which were classified as preventable). SQT Students reported other causes (e.g. Hell Week, Boat PT, buddy carries) as the second most common cause of AllInj followed by lifting. Lifting was the second most common cause of PrevInj in SQT Students. CQT Students reported lifting as the second most common cause of AllInj and PrevInj, followed by other causes (e.g. calisthenics during BCT, surf passage, underways).

AllInj and PrevInj types reported during physical and tactical training evolutions are listed in **Table 31**.

Table 31. AllInj and PrevInj types during physical and tactical training

Injury type	SQT (AllInj)		SQT (PrevInj)		CQT (AllInj)		CQT (PrevInj)	
	n	%	n	%	n	%	n	%
Bursitis	2	0.7	0	0.0	2	1.7	2	2.2
Chondromalacia/patellofemoral pain	2	0.7	2	1.0	1	0.9	1	1.1
Disc injury	1	0.4	1	0.5	0	0.0	0	0.0
Dislocation/Subluxation	3	1.1	2	1.0	3	2.6	2	2.2
Fracture	21	7.4	1	0.5	4	3.4	1	1.1
Impingement	8	2.8	8	4.0	1	0.9	1	1.1
Inflammation	19	6.7	19	9.6	14	12.1	14	15.4
Labral tear	3	1.1	1	0.5	1	0.9	1	1.1
Meniscal	8	2.8	4	2.0	0	0.0	0	0.0
Nerve	14	4.9	9	4.5	1	0.9	1	1.1
Pain / spasm / ache	34	12.0	20	10.1	16	13.8	8	8.8
Periostitis	3	1.1	3	1.5	4	3.4	4	4.4
Sprain	40	14.1	21	10.6	17	14.7	7	7.7
Strain	41	14.4	32	16.2	8	6.9	5	5.5
Stress fracture	44	15.5	43	21.7	19	16.4	19	20.9
Tendonitis / tenosynovitis / tendinopathy	28	9.9	27	13.6	21	18.1	21	23.1
Other	12	4.2	5	2.5	2	1.7	2	2.2
Unknown	1	0.4	0	0.0	2	1.7	2	2.2
Total	**284**		**198**		**116**		**91**	

The three most common AllInj types for SQT Students were stress fractures (15.5%), strains (14.4%), and sprains (14.1%). Stress fractures accounted for the highest percentage of PrevInj (21.7%), followed by strains (16.2%), and tendinopathies (13.6%). The three most common AllInj types for CQT Students were tendinopathies (18.1%), stress fractures (16.4%), and sprains (14.7%). Tendinopathies accounted for the highest percentage of PrevInj (23.1%), followed by stress fractures (20.9%), and inflammation (15.4%).

Injuries Reported by SQT Students

The number of AllInj and PrevInj reported by SQT Students during each phase of training are listed in **Table 32**. AllInj reported during physical training, tactical training, boating, and on the obstacle course without a specified training evolution are also listed in this table. In this instance, injuries reported during physical training specifically did not occur during BUD/S, but did occur during organized military activities. In most cases, this is physical training during SQT.

Table 32. SQT Student AllInj and PrevInj reported in each phase of training

Phase	SQT (AllInj)		SQT (PrevInj)	
	n	%	n	%
BUD/S Prep	8	2.8	8	4.0
BUD/S Orientation	1	0.4	1	0.5
BUD/S	138	48.6	105	53.0
Combatives	17	6.0	1	0.5
LW Niland	7	2.5	3	1.5
TAO	7	2.5	0	0.0
O Course	13	4.6	3	1.5
PT	81	28.5	72	36.4
TT	7	2.5	3	1.5
Grad PT	1	0.4	1	0.5
Boating	2	0.7	1	0.5
SURFOPS	1	0.4	0	0.0
Swimming	1	0.4	0	0.0
Total	**284**		**198**	

Of the AllInj and PrevInj reported by SQT Students since enlistment data, most occurred during BUD/S (48.5% of AllInj, 53.0% of PrevInj) and physical training (28.5% of AllInj, 36.4% of PrevInj). All AllInj reported during BUD/S Prep were lower extremity overuse injuries (stress fractures and medial tibial stress syndrome/"shin splints") attributed to running volume, running surface (pavement outside and indoor track), and lack of running/activity at boot camp prior to beginning BUD/S Prep. All AllInj during TAO were acute knee and ankle injuries (sprains and meniscal tears); 3 occurred during static line, 1 during freefall, and 1 practicing parachute landing falls.

The number of AllInj and PrevInj reported during each phase of BUD/S are listed in **Table 33**. The anatomic location of AllInj and PrevInj reported during BUD/S are reported in **Table 34**.

Table 33. SQT Student AllInj and PrevInj reported in each phase of BUD/S

BUD/S Phase	SQT (AllInj)		SQT (PrevInj)	
	n	%	n	%
1st Phase	63	45.7	49	46.7
2nd Phase	8	5.8	5	4.8
3rd Phase	5	3.6	1	1.0
Not specified	62	44.9	50	47.6
Total	**138**		**105**	

Table 34. Anatomic Location of BUD/S AllInj and PrevInj

Injury anatomic location	Anatomic sub-location	SQT (AllInj)		SQT (PrevInj)	
		n	%	n	%
Lower extremity	Hip	13	9.4	13	24.8
	Thigh	24	17.4	24	45.7
	Knee	12	8.7	6	11.4
	Lower Leg	18	13.0	18	34.3
	Ankle	12	8.7	11	21.0
	Foot/Toes	10	7.2	6	11.4
Upper extremity	Shoulder	21	15.2	14	26.7
	Elbow	3	2.2	1	1.9
	Wrist	1	0.7	0	0.0
	Hand/Fingers	4	2.9	1	1.9
Spine	Cervical	6	4.3	4	7.6
	Thoracic	1	0.7	0	0.0
	Lumbopelvic	11	8.0	7	13.3
	Other	0	0.0	0	0.0
Torso	Abdomen	2	1.4	0	0.0
	Total	**138**		**105**	

Most AllInj and PrevInj reported during BUD/S had an acute onset (67.4% of AllInj, 64.8% of PrevInj) and were overuse injuries (81.9% of AllInj, 91.4% of PrevInj). Most AllInj occurred during BUD/S 1st Phase.

The most common AllInj and PrevInj anatomic location was the thigh: 10 femoral stress fractures (during Hell Week, Log PT, Boat PT, and all running), 8 iliotibial band syndrome (attributed to running), 5 muscle strains or pain/spasm/ache (attributed to running), and 1 incidence of sciatica (attributed to Log PT and Boat PT). The shoulder was the second most common AllInj anatomic location and the third most common PrevInj location. There were 6 tendinopathies or strains of the rotator cuff (4 of which were attributed to Log PT and Boat PT, and one each during an open ocean swim, rock portage, and Grinder PT), 5 brachial plexus injuries (2 during Hell Week, 3 during Boat PT and Log PT), 3 incidences of impingement (all during Boat PT and Log PT), 3 glenohumeral

dislocations/subluxations (1 during Boat PT, 1 during surf passage, and 1 during BUD/S 3rd Phase), 3 reported shoulder pain/spasm/ache (1 from swimming, 2 during Hell Week), and 1 Student reported a labral tear (from weight lifting). The lower leg was the third most common AllInj anatomic location and the second most common PrevInj location. Eight of which were tibial stress fractures, 6 medial tibial stress syndrome or "shin splints," and 4 tendonitis or strains (of the Achilles tendon, gastrocnemius, or anterior tibialis), all related to running and Hell Week.

In addition to the 10 femoral stress fractures and 8 tibial stress fractures, there were 5 metatarsal stress fractures and 2 pelvic stress fractures diagnosed during BUD/S, all attributed to Hell Week and running during BUD/S 1st Phase. Hip injuries (hip flexor strains/tendinopathy, femoral acetabular impingement, snapping hip/bursitis, and pain/spasm ache) were all reported during Hell Week and running.

The anatomic location of AllInj and PrevInj reported by SQT Students during physical training are reported in **Table 35**.

Table 35. Anatomic location of SQT Student AllInj and PrevInj during physical training

Injury anatomic location	Anatomic sub-location	SQT (AllInj)		SQT (PrevInj)	
		n	%	n	%
Lower extremity	Hip	3	3.7	3	8.3
	Thigh	6	7.4	6	16.7
	Knee	7	8.6	7	19.4
	Lower Leg	12	14.8	12	33.3
	Ankle	13	16.0	12	33.3
	Foot/Toes	13	16.0	11	30.6
Upper extremity	Shoulder	13	16.0	10	27.8
	Elbow	2	2.5	2	5.6
Spine	Cervical	1	1.2	0	0.0
	Lumbopelvic	8	9.9	8	22.2
Torso	Chest	1	1.2	0	0.0
	Abdomen	1	1.2	1	2.8
Head	Nose	1	1.2	0	0.0
Total		**81**		**72**	

Most AllInj and PrevInj reported during physical training had an acute onset (87.9% of AllInj, 59.7% of PrevInj) and were overuse injuries (69.1% of AllInj, 72.2% of PrevInj). Most AllInj occurred during running (59.2%) and lifting (22.2%).

AllInj and PrevInj during physical training were relatively evenly distributed between the shoulder, lower leg, ankle, foot/toes, and lumbopelvic region. Lower extremity AllInj occurred primarily during running, and shoulder and lumbopelvic AllInj occurred primarily during lifting. At the lower leg, there were 10 tibial stress fractures and 2 medial tibial stress syndrome or "shin splints," all during running, except for 1 Student who attributed his injury to rucking. At the ankle, there were 11 ankle sprains and 2 Achilles tendonitis; 10 of these AllInj occurred during running, 1 during calisthenics, and 1 while rucking. All reported foot/toe AllInj occurred during running: 7 plantar fasciitis, 3 metatarsal stress fractures, 1 calcaneal stress fracture, 1 sesamoid fracture, and 1 mid-foot sprain. Eight SQT Students reported shoulder AllInj due to lifting and 1 Student reported an AllInj due to calisthenics (1 subacromial impingement, 1 labral tear, and 7 rotator cuff strains). The remaining 4 shoulder AllInj (2

neuropathies, 1 pain/spasm/ache, and 1 tendinopathy) occurred during running, marching, and unspecified activities. Of the 8 lumbopelvic region AllInj, 3 were low back pain and 3 were perispinal strains from lifting; the remaining two lumbopelvic AllInj (a stress fracture to the pelvis and an unspecified nerve injury) did not have reported causes.

Injuries reported by CQT Students

The number of AllInj and PrevInj reported by CQT Students during each phase of training are listed in **Table 36**. AllInj reported during physical training and on the obstacle course without a specific training evolution are also listed in this table. In this instance, AllInj reported during physical training specifically did not occur during BCT, but did occur during organized military activities. In most cases, this is physical training during CQT.

Table 36. CQT Student AllInj and PrevInj reported in each phase of training

Phase	CQT (AllInj)		CQT (PrevInj)	
	n	%	n	%
Boot Camp	4	3.4	3	3.3
BUD/S Prep	25	21.6	23	25.3
BUD/S 1	2	1.7	2	2.2
BCT	21	18.1	15	16.5
Combatives	7	6.0	2	2.2
Navigation/FLETA HOT	3	2.6	0	0.0
Heavy Weapons	2	1.7	2	2.2
Small Arms	2	1.7	2	2.2
O Course	7	6.0	2	2.2
Physical Training	43	37.1	40	44.0
Total	**116**		**91**	

CQT Students reported most AllInj and PrevInj during physical training (37.1% of AllInj, 44.0% of PrevInj). All AllInj reported during BUD/S Prep were to the lower extremity and 96.0% were overuse (stress fractures to the tibia, femur, and calcaneus, medial tibial stress syndrome, plantar fasciitis, iliotibial band syndrome, and Achilles tendonitis); all of these overuse AllInj were attributed to running volume, running surface (pavement outside and indoor track), and lack of running/activity at boot camp prior to beginning BUD/S Prep. Most of the AllInj reported on the obstacle course had an acute onset (85.7%). All upper extremity AllInj on the obstacle course were caused by climbing (triceps strain, deltoid strain, shoulder pain); all lower extremity and spine AllInj on the obstacle course were from falls (ankle sprain, back pain).

The anatomic location of AllInj and PrevInj reported during BCT and physical training evolutions are reported in **Table 37**.

Table 37. Anatomic location of BCT AllInj and PrevInj

Injury anatomic location	Anatomic sub-location	CQT (AllInj)		CQT (PrevInj)	
		n	%	n	%
Lower extremity	Hip	1	4.8	1	6.7
	Thigh	4	19.0	4	26.7
	Knee	2	9.5	2	13.3
	Lower Leg	2	9.5	2	13.3
	Ankle	4	19.0	2	13.3
	Foot/Toes	1	4.8	1	6.7
Upper extremity	Shoulder	4	19.0	2	13.3
	Elbow	1	4.8	1	6.7
	Wrist	1	4.8	0	0.0
	Hand/Fingers	1	4.8	0	0.0
Total		**21**		**15**	

Most AllInj reported during BCT had an acute onset (66.7% of AllInj, 60.0% of PrevInj) and were overuse (66.7% of AllInj, 86.7% of PrevInj). Most AllInj were to the lower extremity and were caused by running.

Of the four thigh AllInj reported, 3 were iliotibial band syndrome caused by running and 1 was an adductor strain during calisthenics. Although 3 of the 4 ankle AllInj occurred during running, only 1 was pain from excessive running, 2 were sprains from stepping off a curb/missteps. Four shoulder AllInj were reported during BCT, but most CQT Students were unsure of the exact mechanism, except for 1 Student who reported a labral tear after a rope climb. Both lower leg AllInj reported during BCT were tibial stress fractures from running.

The anatomic location of AllInj and PrevInj reported during physical training evolutions are reported in **Table 38**.

Table 38. Anatomic location of CQT Student AllInj and PrevInj during physical training

Injury anatomic location	Anatomic sub-location	CQT (AllInj)		CQT (PrevInj)	
		n	%	n	%
Lower extremity	Hip	1	2.3	1	2.5
	Thigh	5	11.6	5	12.5
	Knee	8	18.6	8	20.0
	Lower Leg	8	18.6	8	20.0
	Ankle	6	14.0	5	12.5
	Foot/Toes	6	14.0	6	15.0
Upper extremity	Shoulder	5	11.6	4	10.0
	Upper Arm	1	2.3	1	2.5
	Hand/Fingers	1	2.3	0	0.0
Spine	Lumbopelvic	2	4.7	2	5.0
Total		**43**		**40**	

Most AllInj reported during physical training had an acute onset (62.8% of AllInj, 60.0% of PrevInj) and were overuse (73.7% of AllInj, 82.5% of PrevInj). Most AllInj occurred during running (81.3%).

AllInj and PrevInj during physical training were relatively evenly distributed between knee, lower leg, ankle, foot/toes, and shoulder. Lower extremity AllInj occurred during running and shoulder AllInj occurred during calisthenics. At the knee, AllInj reported include 2 patellar tendinopathyies 2 knee pain, 1 pes anserine bursitis, 1 chondromalacia patella, and 2 unspecified AllInj, all caused by running. At the lower leg, there were 3 tibial stress fractures and 5 reported medial tibial stress syndrome/"shin splints" or tibial periostitis, all from running in sand and running in boots. At the ankle, there were 4 ankle sprains and 2 Achilles tendonitis, all of which occurred during running, except for 1 ankle sprain with an unspecified cause. At the foot, there were 3 plantar fasciitis, 1 metatarsal stress fracture, 1 turf toe, and 1 unspecified tendonitis, all from running. Of the five shoulder AllInj reported, 1 glenohumeral subluxation occurred during the weighted pull-up test in TAP, 2 rotator cuff strains during calisthenics, 1 tendinopathy from a buddy carry, and an AC joint sprain from a fall.

Considerations and Limitations

This investigation is part of comprehensive laboratory testing. Therefore, subjects must have met inclusion criteria, which may have potentially excluded Students who suffered serious injuries. Those who suffer serious musculoskeletal injuries are likely to have been rolled or dropped from training and may have been assigned to different units or services outside of the Special Operations community. That would likely mean that this study includes only Students who have completed training without major injuries. Not all Students had completed the training pipeline at the time of survey and all were surveyed at different points in the training pipeline, therefore this data may not present a complete picture of injuries that occur during SEAL and SWCC training pipelines. This may result in underestimation of actual injury counts. Collecting injury data using self-report methods is a valid and accepted practice in injury epidemiological research.[39-41] This self-reported data covers a period greater than one-year, which may affect accuracy of injury recall.[34, 39, 45] Longer periods of recall are associated with underreporting injuries,[33, 42, 46] However, Students consistently report hiding injuries from instructors, corpsman, and

medical personnel to avoid being rolled or dropped from training; therefore, this self-report method captured injuries that would have been missed in medical chart reviews, offsetting any underreporting due to the longer recall period. Past research has shown that individuals in overall good health, younger age, and with higher education accurately report injuries,[42, 43] particularly those perceived as more traumatic (e.g. fractures or as in this case, those associated with rolls from training).[42, 44, 45]

Appendix B. Physical Training Injuries

PrevInj reported by each group during physical training are presented in **Tables 39**, **40**, **41**, and **42**.

The following abbreviations are used in these tables:

NS: Not Specified
IT: Iliotibial band
ACL: Anterior cruciate ligament
MCL: Medical collateral ligament
ATF: Anterior talofibular ligament
CF: Calcaneofibular ligament

Table 39. PrevInj reported during physical training by SQT Students

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	hip	hip-flexor	strain	Hip flexor sprain		Right	Running	Running
lower extremity	hip	external rotators	strain			Right	Other	Other
lower extremity	hip	hip-flexor	strain			Right	Running	BUDS
lower extremity	hip		bursitis			Left	Running	BUDS
lower extremity	thigh	IT band	tendinopathy		Running during PTRR	Right	Running	Running
lower extremity	thigh	IT band	tendinopathy	ITB strain	Running	Right	Running	BUDS
lower extremity	thigh	hamstring	strain		Felt "pull" during descent phase of deadlift	Left	Other	Weight Lifting
lower extremity	thigh	IT band	tendinopathy			NS	Running	BUDS
lower extremity	thigh	sciatic nerve	nerve		Log PT and Boat PT	Right	Lifting	BUDS
lower extremity	knee		pain/spasm/ache		Overuse	NS	Running	Running
lower extremity	knee	infrapatellar	pain/spasm/ache		Overuse	NS	Running	Running
lower extremity	knee	patella	tendinopathy	Patellar tendinitis		Right	Running	BUDS
lower extremity	knee	patella	tendinopathy		Mechanics for deadlift, cleans and snatches corrected by TAP staff resulted in patellar tendonitis	Right	Lifting	Physical Training
lower extremity	lower leg	tibia	stress fracture	Tibial stress fracture	Overuse injury	Right	Running	Running
lower extremity	lower leg	tibia	periostitis		Overuse running injury, would re-occur during different phases (PTRR and BUDs 3rd phase)	NS	Running	Running
lower extremity	lower leg	tibia	stress fracture			Right	Running	Running

Table 39. PrevInj reported during physical training by SQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	lower leg	other	strain	Posterior tibialis strain		Left	Running	BUDS
lower extremity	ankle	ATF	sprain		Inversion sprain	Right	Running	Running
lower extremity	ankle	achilles	tendinopathy		Overuse	NS	Running	Running
lower extremity	ankle	ATF	sprain		Uneven, mountain terrain; inversion sprain	Left	Running	Running
lower extremity	ankle	ATF	sprain		Inversion sprain	Right	Planting	Physical Training
lower extremity	ankle	CF	sprain		Running on uneven terrain	Right	Running	Running
lower extremity	ankle	ATF	sprain		Inversion sprain	Right	Running	Running
lower extremity	ankle	ATF	sprain		Ruck hike; inversion sprain	Left	Landing	Other
lower extremity	ankle	ATF	sprain		Repeated inversion sprains	Right	Running	BUDS
lower extremity	ankle	gastroc-soleus	strain			Right	Running	Running
lower extremity	ankle	ATF	sprain		Landing when coming down from pull up bar	Right	Landing	Physical Training
lower extremity	ankle	ATF	sprain		Running in soft sand	Right	Running	BUDS
lower extremity	foot and toes	plantar fascia	inflammation		Overuse	Right	Running	Running
lower extremity	foot and toes	plantar fascia	inflammation		Excessive running and swimming with fins	Bilateral	Running	Running
lower extremity	foot and toes	other	stress fracture	Calcaneus		Left	Running	Running
lower extremity	foot and toes	metatarsals	stress fracture	3rd metatarsal		Right	Running	Running
lower extremity	foot and toes	plantar fascia	inflammation			Left	Running	Running
lower extremity	foot and toes	plantar fascia	inflammation			Left	Running	Running

Table 39. PrevInj reported during physical training by SQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	foot and toes		pain/spasm/ache	Plantar foot pain	Unsure, occurred during CO PT swim/run graduation week	Right	Running	Running
lower extremity	foot and toes	plantar fascia	inflammation		Running volume during 1st phase/Hell week	NS	Running	BUDS
upper extremity	shoulder	rotator cuff	tendinopathy		Log PT and Boat PT (lifting overhead during these evolutions)	Bilateral	Lifting	BUDS
upper extremity	shoulder	rotator cuff	tendinopathy		Overuse, repetitive overhead lifts	Right	Lifting	Physical Training
upper extremity	shoulder	rotator cuff	tendinopathy			Left	Lifting	Weight Lifting
upper extremity	shoulder	other	nerve	Musculocutaneous nerve rupture		Left	Lifting	BUDS
upper extremity	shoulder	other	strain	Latissimus dorsi strain		Right	Pulling	Physical Training
upper extremity	shoulder	subacromial	impingement		Bench press	Left	Lifting	Weight Lifting
upper extremity	shoulder	rotator cuff	strain		Strained during maximum rep bench press test during TAP assessment	Right	Lifting	Weight Lifting
upper extremity	shoulder	subacromial	impingement		Overuse during training in 2nd Phase	Right	NS	BUDS
upper extremity	shoulder		pain/spasm/ache	Posterior rotator cuff weakness	Swimming during 2nd phase	Right	Other	BUDS
upper extremity	elbow		tendinopathy	Medial epicondylitis		Right	Pulling	Physical Training
upper extremity	elbow		other	Bursitis		Right	Lifting	Weight Lifting
spine	lumbopelvic	paraspinals	strain		Excessive body weight squats	Right	Other	BUDS
spine	lumbopelvic	paraspinals	strain		Doing sit-ups with log (Log PT)	Right	Lifting	Physical Training
spine	lumbopelvic		strain		Deep squats with weight	Bilateral	Lifting	Weight Lifting

Table 39. PrevInj reported during physical training by SQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
spine	lumbopelvic	paraspinals	strain		Improperly dropping a barbell	Bilateral	Lifting	Weight Lifting
spine	lumbopelvic		pain/spasm/ache	Chronic low back pain	Instructor led weight lifting	Bilateral	Lifting	Weight Lifting
spine	lumbopelvic		pain/spasm/ache	Low back pain	Unsure (performed deadlifts, good mornings, bent over rows)	Bilateral	Lifting	Weight Lifting
spine	lumbopelvic	paraspinals	strain		Deadlifts	Bilateral	Lifting	Weight Lifting
spine	lumbopelvic		pain/spasm/ache	Low back pain	Squats	Bilateral	Lifting	Physical Training
torso	abdomen	abdominal muscle	strain		Heavy back squats	Left	Lifting	Weight Lifting

Table 40. PrevInj reported during physical training by G2 Operators

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	thigh	IT band	tendinopathy		Running	Right	Running	Running
lower extremity	knee	ACL	sprain		Buddy Carry	Right	Other	Other
lower extremity	knee		tendinopathy	Tendonitis	Overuse from running	NS	Running	Running
lower extremity	ankle		sprain		Rolled ankle while running with body armor	Right	Running	Running
upper extremity	shoulder		pain/spasm/ache		Weight lifting	Left	Lifting	Weight Lifting
upper extremity	shoulder		labral tear	Labral tear and supraspinatus tendon tear	Occurred while lifting (snatch)	Right	Lifting	Weight Lifting
upper extremity	shoulder		labral tear		Noticed pain during weightlifting; then fell on outstretched arm while hiking	Left	Lifting	Weight Lifting
upper extremity	shoulder	pectorals	tendinopathy		Started hurting during lifting, currently hurts during bench press, push-ups, and any horizontal adduction with weight	Left	Lifting	Weight Lifting
upper extremity	shoulder	rotator cuff	strain		Unable to control weight of dumbbell, this caused excessive external rotation	Right	Lifting	Weight Lifting
upper extremity	elbow		tendinopathy			Right	Lifting	Weight Lifting
upper extremity	elbow		tendinopathy	Tendonitis	Weightlifting 110 pound dumbbells on a flat bench press	Right	Lifting	Weight Lifting
spine	thoracic		strain		Back workout	Right	Lifting	Weight Lifting
spine	lumbopelvic		strain		Weight lifting	Right	Lifting	Weight Lifting
spine	lumbopelvic	paraspinals	strain		Kettlebell lifts	Right	Lifting	Weight Lifting
spine	lumbopelvic		strain		Deadlifts	Right	Lifting	Weight Lifting

Table 40. PrevInj reported during physical training by G2 Operators, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
spine	lumbopelvic		pain/spasm/ache	Low back pain	Doing squats with too much weight, got out of stability plane and felt sharp pain in back.	Bilateral	Lifting	Weight Lifting
spine	lumbopelvic	paraspinals	strain		Doing front squats with too much weight and poor form	NS	Lifting	Weight Lifting
spine	lumbopelvic	paraspinals	strain		Deadlifts	Bilateral	Lifting	Weight Lifting

Table 41. PrevInj reported during physical training by CQT Students

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	hip		sprain		Overuse	Left	Running	Running
lower extremity	hip		other	Capsulitis	Overuse	Right	Running	BCT
lower extremity	thigh	adductor	strain		Overuse and awkward positioning	Right	Other	BCT
lower extremity	thigh	IT band	tendinopathy		Overuse, running	Right	Running	Running
lower extremity	thigh	IT band	tendinopathy			NS	Running	Running
lower extremity	thigh	IT band	tendinopathy		Running on soft sand	Right	Running	BCT
lower extremity	thigh	IT band	tendinopathy		Excessive running volume	NS	Running	BCT
lower extremity	thigh	IT band	tendinopathy			NS	Running	BCT
lower extremity	thigh	IT band	tendinopathy		Large running volume (12-14 miles) and running on indoor track at BUD/S Prep	NS	Running	Running
lower extremity	thigh	IT band	tendinopathy		Running surface (pavement) at BUD/S Prep	Right	Running	Running
lower extremity	knee		NS		Overuse	Right	Running	Physical Training
lower extremity	knee		NS		Overuse	Right	Running	Running
lower extremity	knee	patella	tendinopathy		Overuse running injury	Right	Running	Running
lower extremity	knee	pes anserine	bursitis			Left	Running	Running

Table 41. PrevInj reported during physical training by CQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	knee	patella	tendinopathy	Patellar tendonitis	Day 2 of the Tour, unsure of exact mechanism but remembers severe pain with running and during duck walks	Right	Running	BCT
lower extremity	knee		pain/spasm/ache		Knee pain after first run on soft sand in running shoes (not combat boots) in "a long time"	Right	Running	Running
lower extremity	knee		pain/spasm/ache		First time running on concrete after only running on the beach	Left	Running	Running
lower extremity	knee		pain/spasm/ache		Attributes knee pain to excessive running during the Tour, unsure exactly when it started	Right	Running	BCT
lower extremity	knee	patella	tendinopathy	Patellar tendonitis	Ran on concrete in shoes after only running on the beach in boots	Right	Running	Running
lower extremity	knee	other	bursitis		Running in soft sand in boots	NS	Running	Running
lower extremity	lower leg	tibia	periostitis		Overuse	NS	Running	Running
lower extremity	lower leg	tibia	periostitis		Overuse	NS	Running	Running
lower extremity	lower leg	tibia	stress fracture		Overuse	NS	Running	Running
lower extremity	lower leg	tibia	stress fracture		Drastic increase in running volume during BCT	NS	Running	BCT

Table 41. PrevInj reported during physical training by CQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	lower leg	tibia	stress fracture		Large running volume during pre-BUD/S	NS	Running	Running
lower extremity	lower leg	tibia	stress fracture		Increased running volume during pre-BUD/S ("after doing basically nothing at boot camp")	Left	Running	Physical Training
lower extremity	lower leg		inflammation	Shin splints	Lack of physical activity in boot camp before high running volume during BUD/S Prep	NS	Running	Running
lower extremity	lower leg		inflammation	Medial tibial stress syndrome	Increased running volume at boot camp	NS	Running	Running
lower extremity	lower leg	tibia	stress fracture	Tibial stress fracture	Large running volume at BUD/S Prep	Left	Running	Running
lower extremity	lower leg	tibia	stress fracture	Tibial stress fracture	Running on sand	Left	Running	BCT
lower extremity	lower leg	tibia	stress fracture	Tibial stress fracture	Had never run farther than one mile before starting BUD/S Prep	NS	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Running volume at BUD/S prep	NS	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Running indoors on track at BUD/S prep	NS	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Running volume at BUD/S prep	Left	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Running on concrete	NS	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Running volume and running on concrete at BUD/S Prep	NS	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Running surface (pavement) at BUD/S Prep	Left	Running	Running

Table 41. PrevInj reported during physical training by CQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	lower leg		inflammation	Shin splints	Running volume, running surface, running in boots at Boot Camp	NS	Running	Running
lower extremity	lower leg		inflammation	Shin splints	Wearing boots for all activities at BUD/S Prep	NS	Running	Other
lower extremity	ankle	achilles	tendinopathy			Right	Running	Running
lower extremity	ankle	ATF	sprain			Right	Running	Running
lower extremity	ankle	ATF	sprain			Left	Running	Running
lower extremity	ankle		sprain		Rolled ankle and fell off curb	Right	Twist/Turn/Slip (no fall)	BCT
lower extremity	ankle		pain/spasm/ache	Bilateral chronic ankle swelling	Excessive running during BCT	Bilateral	Running	BCT
lower extremity	ankle	achilles	tendinopathy		Sprinting to keep up with his class on a beach run	Right	Running	Running
lower extremity	ankle	achilles	tendinopathy		Running on indoor track during BUD/S Prep	Right	Running	Running
lower extremity	ankle	ATF	sprain		Rolled ankle running downhill	Left	Running	Running
lower extremity	foot and toes		tendinopathy		Overuse	NS	Running	Running
lower extremity	foot and toes	foot	stress fracture		Overuse, running	Left	Running	Other
lower extremity	foot and toes	plantar fascia	inflammation			Right	Running	Running
lower extremity	foot and toes	metatarsals	stress fracture	2nd and 5th metatarsals		Right	Running	Running
lower extremity	foot and toes	other	strain	Flexor hallucis strain		Right	Running	Running

Table 41. PrevInj reported during physical training by CQT Students, continued

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	foot and toes	calcaneus	stress fracture	Calcaneal stress fractures	Increased running volume during pre-BUD/S	Bilateral	Running	Physical Training
lower extremity	foot and toes	plantar fascia	inflammation		Large running volume at BUD/S Prep	NS	Running	Running
upper extremity	shoulder	rotator cuff	strain		Push ups	Left	Other	Physical Training
upper extremity	shoulder		tendinopathy		Buddy carries	Right	Other	Physical Training
upper extremity	shoulder	rotator cuff	strain		Overuse secondary to conditioning programs	Right	Lifting	Physical Training
upper extremity	shoulder	glenohumeral	subluxation		Shoulder subluxed while performing weighted pull-ups (25lb weight vest) during TAP assessment	Left	Lifting	Weight Lifting
upper extremity	shoulder		pain/spasm/ache		Shoulder pain from carrying boat overhead during BCT, cannot perform weighted overhead activity	Left	Lifting	BCT
upper extremity	upper arm	triceps	strain		Rope climb on O Course	Left	Climbing	Obstacle Course
spine	lumbopelvic		pain/spasm/ache	Low back pain	Deadlifting 135 lbs	NS	Lifting	Weight Lifting
spine	lumbopelvic		pain/spasm/ache		Unsure, "lifted too much weight"	Bilateral	Lifting	Other

Table 42. PrevInj reported during physical training by SBT-22 Operators

Location	Sub-Location 1	Sub-Location 2	Injury Type	Describe Injury	Describe Mechanism	Side	Cause	Activity
lower extremity	thigh	hamstring	strain		Sprints during morning PT	Left	Running	Running
lower extremity	lower leg	IT band	inflammation	IT band syndrome		Left	Running	Running
lower extremity	knee	lateral	meniscal	Lateral meniscus tear	Occurred while extending knee to jump for a high pass	Left	Jump	Other
lower extremity	knee	MCL	sprain		Running forward, planted and jumped to catch the ball. Felt a "pop" in right knee.	Right	Planting	Other
lower extremity	knee		pain/spasm/ache		Running in boots on sand; unaccustomed to activity	Left	Running	Running
lower extremity	lower leg	tibia	stress fracture	Tibial stress fracture	Increased volume of running	Right	Running	Running
upper extremity	shoulder		labral tear		Clean and press (135 lbs); pain during press up	Right	Lifting	Weight Lifting
upper extremity	shoulder	subacromial	impingement		Attribute shoulder pain to working up to performing an iron cross. Onset usually when arm is extended/raised.	Left	NS	Other
upper extremity	shoulder	other	pain/spasm/ache	Upper trapezius pain	Lifting 50 lbs dumbbells during workout-biceps curls	Right	Lifting	Weight Lifting
upper extremity	shoulder	pectorals	tendinopathy	Biceps tendonitis	Overuse injury, result of excessive weight lifting (2 workouts/day)	Right	Lifting	Weight Lifting
upper extremity	upper arm	biceps	tendinopathy	Pectoralis minor tendonitis	Overuse injury, result of excessive weight lifting (2 workouts/day)	Right	Lifting	Weight Lifting

References

1. Skeehan, C.D., et al. *Nonbattle injury among deployed troops: an epidemiologic study.* Mil Med, 2009. **174**(12): p. 1256-62.
2. Bohnker, B.K., et al. *Analysis of Navy Physical Evaluation Board diagnoses (1998-2000).* Mil Med, 2003. **168**(6): p. 482-485.
3. Bullock, S.H., et al. *Prevention of physical training-related injuries recommendations for the military and other active populations based on expedited systematic reviews.* Am J Prev Med, 2010. **38**(1 Suppl): p. S156-81.
4. Hauret, K.G., et al. *Musculoskeletal injuries description of an under-recognized injury problem among military personnel.* Am J Prev Med, 2010. **38**(1 Suppl): p. S61-70.
5. Lauder, T.D., et al. *Sports and physical training injury hospitalizations in the army.* Am J Prev Med, 2000. **18**(3 Suppl): p. 118-28.
6. Litow, C.D. and P.L. Krahl. *Public health potential of a disability tracking system: analysis of U.S. Navy and Marine Corps physical evaluation boards 2005-2006.* Mil Med, 2007. **172**(12): p. 1270-4.
7. Jones, B.H., et al. *Medical surveillance of injuries in the U.S. Military descriptive epidemiology and recommendations for improvement.* Am J Prev Med, 2010. **38**(1 Suppl): p. S42-60.
8. Roy, T.C. *Diagnoses and mechanisms of musculoskeletal injuries in an infantry brigade combat team deployed to Afghanistan evaluated by the brigade physical therapist.* Mil Med, 2011. **176**(8): p. 903-8.
9. Ruscio, B.A., et al. *A process to identify military injury prevention priorities based on injury type and limited duty days.* Am J Prev Med, 2010. **38**(1 Suppl): p. S19-33.
10. Smith, G.S., A.L. Dannenberg, and P.J. Amoroso. *Hospitalization due to injuries in the military. Evaluation of current data and recommendations on their use for injury prevention.* Am J Prev Med, 2000. **18**(3 Suppl): p. 41-53.
11. Songer, T.J. and R.E. LaPorte. *Disabilities due to injury in the military.* Am J Prev Med, 2000. **18**(3 Suppl): p. 33-40.
12. Zambraski, E.J. and K.E. Yancosek. *Prevention and rehabilitation of musculoskeletal injuries during military operations and training.* J Strength Cond Res, 2012. **26 Suppl 2**: p. S101-6.
13. Almeida, S.A., et al. *Epidemiological patterns of musculoskeletal injuries and physical training.* Med Sci Sports Exerc, 1999. **31**(8): p. 1176-82.
14. Grier, T.L., et al. *Risk factors for injuries in the U.S. Army Ordnance School.* Mil Med, 2011. **176**(11): p. 1292-9.
15. Jones, B.H., et al. *Epidemiology of injuries associated with physical training among young men in the army.* Med Sci Sports Exerc, 1993. **25**(2): p. 197-203.
16. Jones, B.H. and B.C. Hansen. *An armed forces epidemiological board evaluation of injuries in the military.* Am J Prev Med, 2000. **18**(3 Suppl): p. 14-25.
17. Jones, B.H., et al. *Injuries in the military: a review and commentary focused on prevention.* Am J Prev Med, 2000. **18**(3 Suppl): p. 71-84.
18. Kaufman, K.R., S. Brodine, and R. Shaffer. *Military training-related injuries: surveillance, research, and prevention.* Am J Prev Med, 2000. **18**(3 Suppl): p. 54-63.
19. Knapik, J., et al. *Physical fitness, age, and injury incidence in infantry soldiers.* J Occup Med, 1993. **35**(6): p. 598-603.
20. Knapik, J.J., et al. *Risk factors for training-related injuries among men and women in basic combat training.* Med Sci Sports Exerc, 2001. **33**(6): p. 946-954.
21. Knapik, J.J., et al. *Injuries before and after deployments to Afghanistan and Iraq.* Public health, 2012. **126**(6): p. 498-506.

22. Abt, J.P., et al. *Injury epidemiology of U.S. Army Special Operations forces.* Mil Med, 2014. **179**(10): p. 1106-12.
23. Hollingsworth, D.J. *The prevalence and impact of musculoskeletal injuries during a pre-deployment workup cycle: survey of a Marine Corps special operations company.* J Spec Oper Med, 2009. **9**(4): p. 11-5.
24. Lynch, J.H. and M.P. Pallis. *Clinical diagnoses in a Special Forces Group: The musculoskeletal burden.* J Spec Oper Med, 2008: p. 76.
25. Peterson, S.N., et al. *Injuries in naval special warfare sea, air, and land personnel: epidemiology and surgical management.* Oper Tech Sports Med, 2005. **13**(3): p. 131-135.
26. Popovich, R.M., et al. *Effect of rest from running on overuse injuries in army basic training.* Am J Prev Med, 2000. **18**(3 Suppl): p. 147-55.
27. Knapik, J.J., et al. *A prospective investigation of injury incidence and risk factors among army recruits in combat engineer training.* J Occup Med Toxicol, 2013. **8**(1): p. 5.
28. Knapik, J.J., et al. *A prospective investigation of injury incidence and injury risk factors among Army recruits in military police training.* BMC Musculoskelet Disord, 2013. **14**: p. 32.
29. Schneider, G.A., C. Bigelow, and P.J. Amoroso. *Evaluating risk of re-injury among 1214 army airborne soldiers using a stratified survival model.* Am J Prev Med, 2000. **18**(3 Suppl): p. 156-63.
30. Peake, J.B. *Reflections on injuries in the military: the hidden epidemic.* Am J Prev Med, 2000. **18**(3 Suppl): p. 4-5.
31. Sell, T.C., et al. *Warrior Model for Human Performance and Injury Prevention: Eagle Tactical Athlete Program (ETAP) Part I.* J Spec Oper Med, 2010. **10**(4): p. 2-21.
32. Bellon, J.A., et al. *Validity of self reported utilisation of primary health care services in an urban population in Spain.* J Epidemiol Community Health, 2000. **54**(7): p. 544-51.
33. Bhandari, A. and T. Wagner. *Self-reported utilization of health care services: improving measurement and accuracy.* Med Care Res Rev, 2006. **63**(2): p. 217-235.
34. Fredriksson, K., et al. *Validity and reliability of self-reported retrospectively collected data on sick leave related to musculoskeletal diseases.* Scand J Work Environ Health, 1998: p. 425-431.
35. van Mechelen, W., H. Hlobil, and H.C. Kemper. *Incidence, severity, aetiology and prevention of sports injuries. A review of concepts.* Sports Med, 1992. **14**(2): p. 82-99.
36. Finch, C.F. *An overview of some definitional issues for sports injury surveillance.* Sports Med, 1997. **24**(3): p. 157-63.
37. Linenger, J.M., et al. *Musculoskeletal and medical morbidity associated with rigorous physical training.* Clin J Sport Med, 1993. **3**(4): p. 229-34.
38. NMRL. *Unintentional musculoskeletal injury epidemiology of the AFSOC Operatory (self-report survey data).* 2015.
39. Gabbe, B., et al. *How valid is a self reported 12 month sports injury history?* Br J Sports Med, 2003. **37**(6): p. 545-547.
40. Mickalide, A. *Threats to measurement validity in self reported data can be overcome.* Inj Prev, 1997. **3**(1): p. 7.
41. Picavet, H. and J. Hazes. *Prevalence of self reported musculoskeletal diseases is high.* Ann Rheum Dis, 2003. **62**(7): p. 644-650.
42. Braun, B.L., S.G. Gerberich, and S. Sidney. *Injury events: utility of self report in retrospective identification in the USA.* J Epidemiol Community Health, 1994. **48**(6): p. 604-5.
43. Short, M.E., et al. *How accurate are self-reports? An analysis of self-reported healthcare utilization and absence when compared to administrative data.* J Occup Environ Med, 2009. **51**(7): p. 786.

44. Begg, D.J., J.D. Langley, and S.M. Williams. *Validity of self reported crashes and injuries in a longitudinal study of young adults.* Inj Prev, 1999. **5**(2): p. 142-4.
45. Lovalekar, M., et al. *Assessing self-reported recall of unintentional musculoskeletal injuries in Naval Special Warfare Operators*. in *141st Annual Meeting & Exposition of the American Public Health Association*. 2013. Boston, MA.
46. Bernard, H.R., et al. *The problem of informant accuracy: The validity of retrospective data.* Annu Rev Anthropol, 1984: p. 495-517.