From the DEPARTMENT OF NEUROBIOLOGY, CARE
SCIENCES AND SOCIETY, Division of Physiotherapy,
Karolinska Institutet, Stockholm, Sweden

PREMATURE DISCHARGE FROM MILITARY SERVICE

Risk Factors and Preventive Interventions

Helena Larsson

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ABSTRACT

The tasks and capabilities of the Swedish Armed Forces are changing to meet new threats all around the world. With the sharp decrease in number of enlisted soldiers, selection is more important than ever. It is also important to prevent soldiers from leaving military service prematurely i.e. from being discharged. The present work has sought to deepen our knowledge in this important field.

The *overall aim* of the work presented in this thesis was to identify risk factors and to describe and analyze the influence of preventive interventions on premature discharge from military service. This was to be achieved by evaluating both a test for selection to physically demanding service and screening tests for identifying risk factors for discharge present at the start of army conscript service. Finally, a specially-tailored comprehensive intervention programme was implemented.

Male conscripts (n=1807) from different army units participated in the four studies during their military service. The investigations were applied within the first week of the conscripts' service. Cases for premature discharge were recorded during service. The lower-limb functional capacity test, the ranger test, was evaluated in a ranger unit. A musculoskeletal screening protocol (MSP) with the main purpose of identifying personnel at risk of premature discharge was developed. The MSP comprised a questionnaire, a lower-limb-loading test with pain-intensity ratings, assessment of passive range of motion, and muscular endurance tests. The comprehensive intervention was implemented in an artillery unit, a ranger unit and an engineer unit. The intervention comprised a course for officers, the MSP followed by early rehabilitation, organised, systematic co-operation between officers and physiotherapist, and physical training programmes.

The ranger test had high discriminating ability and predictive value for premature discharge caused by knee or back problems during strenuous military ranger training. The set of four lower-limb-loading tests was reliable and valid in detecting knee pain. Musculoskeletal complaints or injuries current at the start of the training were common (33-41 %) and independently and significantly associated with premature discharge. Being physically inactive, exposed to high physical load during the first three months of service, perceiving poor mental health, being mentally unprepared or smoking were also predictors of premature discharge. The discharge rate was lower in all three units after the intervention programme had been implemented compared to the previous year.

In conclusion, different risk factors for premature discharge can be identified at the time conscript service begins. A supplemented selection procedure during enrolment for ranger conscripts was important for conscripts who would be highly loaded. The ranger test could be a supplement in the selection of applicants for ranger service, where a minimally acceptable performance standard is suggested. Fewer prematurely discharged conscripts, in comparison with historical data, indicates that the present intervention programme implemented in three army units was effective. The findings provide useful information on potential risk factors, and this highlights the need for improved pre-enlistment examination and early preventive strategies.

Key words: musculoskeletal injury, physiotherapy, intervention, conscript, soldier, functional tests, lower-limb-loading test, self-rated health, predictor.

SAMMANFATTNING

Sveriges försvarsmakt genomgår en förändring för att utföra nya uppgifter runt om i världen. Med den kraftiga minskningen av antalet personer som genomför värnpliktsutbildning får urvalet av dem som skrivs in för tjänstgöring en allt större betydelse. Det är också angeläget att minska risken för att utbildningen avbryts i förtid, ett problem som Sverige och andra länders försvarsmakter brottats med sedan lång tid. Föreliggande arbete avser att fördjupa kunskapen om dessa problemområden.

Det övergripande syftet med denna avhandling har varit att identifiera riskfaktorer och att analysera om förebyggande åtgärder kan minska antalet avgångar från utbildningen. Ett test för urval till fysiskt krävande tjänst, jägartestet och screeningtester för att identifiera riskfaktorer för avgång utvecklades och utvärderades samt ett särskilt framtaget allsidigt interventionsprogram infördes och utvärderades.

I studierna deltog 1807 manliga värnpliktiga under utbildning vid olika arméförband. Testerna genomfördes i samband med att utbildningen började. Avgångar från utbildningen registrerades. Testet som avser att bedöma funktion och kapacitet av nedre extremiteterna inför fysiskt krävande tjänst, jägartestet, utvärderades vid ett jägarförband. Screeningtesterna utvärderades i två studier och kom därefter att omfatta: ett frågeformulär, ett test för nedre extremiteter bestående av fyra olika belastande rörelser med skattning av knäsmärta, mätning av rörlighet och ett muskeluthållighetstest. Interventionsprogrammet infördes vid ett artilleri-, ett ingenjörs- och ett jägarförband. Programmet omfattade befälsutbildning, screeningtesterna, rehabilitering och förebyggande åtgärder för de som identifierades genom screeningen. Ett organiserat systematiskt samarbete mellan officerare och sjukgymnast för att anpassa och justera belastningen pågick under hela utbildningen och specifika individuella träningsprogram utarbetades.

Resultaten visade att jägartestet identifierade värnpliktiga med ökad risk för avgång från fysiskt krävande jägartjänst. Testet, bestående av fyra olika rörelser med smärtskattning, visade sig vara tillförlitligt och hade validitet för att identifiera individer med knäsmärta. Besvär i rörelseapparaten var vanligt förekommande, 33-41 % hade aktuella besvär då utbildningen började, vilket var en signifikant och oberoende riskfaktor associerad med avgång. Att vara fysisk inaktiv, bli exponerad med hög fysisk belastning under de första månaderna, ha en självupplevd dålig mental hälsa, att vara mentalt oförberedd inför utbildningen och att vara rökare var andra oberoende riskfaktorer som associerade med avgång. Vid alla tre förband där interventionsprogrammet genomfördes minskade antalet avgångar signifikant jämfört med tidigare år. Av olika skäl genomfördes interventionen med olika intensitet vid förbanden och resultaten visar att när programmet genomfördes som planerat var antalet avgångar mindre än hälften jämfört med när programmet genomfördes mindre intensivt.

Olika riskfaktorer för avgång kan identifieras i samband med att utbildningen börjar. En kompletterad urvalsprocess vid mönstringen av värnpliktiga till fysisk belastande tjänst var viktig. Jägartestet föreslås utgöra ett kompletterande test av sökande till jägarbefattning, kravgräns för inskrivning har föreslagits. En minskning av antalet avgångar jämfört med historiska data indikerar att interventionsprogrammet, som infördes vid tre olika förband, var effektivt. Fynden i denna avhandling utgör viktig information om potentiella riskfaktorer för avgång och verifierar behovet av utökad undersökning inför inskrivning för militärtjänst samt att strategier för förebyggande åtgärder i samband med utbildningen är nödvändiga.

Nyckelord: Muskuloskeletala besvär, sjukgymnastik, intervention, funktionella test, belastande nedre extremitets test, självskattad hälsa.

LIST OF PUBLICATIONS

This thesis is based on the following publications, which will be referred to in the text by their Roman numerals (I-IV):

I. Larsson H, Harms-Ringdahl K. A Lower-Limb Functional Capacity Test for Enlistment into Swedish Armed Forces Ranger Units. Military Medicine 2006, 171:1065-1070.

II. Larsson H, Larsson M, Österberg H, Harms-Ringdahl K. Screening Tests Detect Knee Pain and Predict Discharge from Military Service. Military Medicine 2008, 173:259-265.

III. Larsson H, Broman L, Harms-Ringdahl. Individual Risk Factors Associated with Premature Discharge from Military Service. Military Medicine 2009, 174:9-20.

IV. Larsson H, Tegern M, Harms-Ringdahl K. Influence of a comprehensive intervention programme on premature discharge outcomes from military service - a longitudinal study (in manuscript).

HOW I BECAME INVOLVED

Twenty years ago I was asked whether I could develop a muscle endurance test battery for enlistment to the Swedish paratroops. At the time, I was working as a physiotherapist, mainly with rehabilitation and ergonomics. I accepted, and for the next ten years thousands of applicants were tested for maximal and sub-maximal muscle performance. After a while, the ranger test was developed, and in 1997 it was introduced as part of the enrolment procedure for applicants to the Swedish Armed Forces ranger units. The test was evaluated in a ranger unit and discussion of the resulting data constitutes the first part of this thesis.

Working in ranger units as well as in others with conscripts suffering from musculoskeletal complaints during basic training, it became clear to me that a strategy was needed to prevent aggravation of current musculoskeletal complaints or injuries during conscript service.

As physiotherapist to the Swedish National Parachute team and the Swedish Military Endurance team I have worked with 'pre-season tests', following the teams during training and at the competitions. Based on this experience and the test battery that I developed and applied in sports medicine, an ergonomic project was started. This took the form of an intervention for a group of civilian car mechanics working for the Swedish Armed Forces. The outcome was fewer workers sick-listed for musculoskeletal disorders and fewer relapses than before the intervention. For me, it became obvious that this was something that could be used for other groups, for example conscripts during military service.

Once all the puzzle bits were in place and the method was to be tried, the die was cast: the pilot study for my doctorate was carried out with 578 fresh conscripts. Several thousand have since been tested in different ways and my thesis discusses the results. In parallel with the work on my doctorate I have established that the method is applicable in clinical practice, and I hope it may be implemented smoothly throughout the Swedish Armed Forces.

An area given high priority by the Supreme Commander of the Swedish Armed forces is that individuals starting their military service should have the prerequisites to complete it without risk of discharge, and should subsequently be prepared for their future tasks

It is my firm conviction that the method presented in this thesis is relevant in other contexts and for other occupational groups than conscripts undergoing training.

Alea iacta est Helena Larsson

CONTENTS

ABBREVIATIONS

BCT	Basic combat training
ISAF	International Security Assistance Force
MNILK	Nordic Military Sports Leader Conference
BMI	Body mass index
MSCI	Musculoskeletal complaints or injuries
MSP	Musculoskeletal screening protocol
APFT	Army physical fitness test i.e. a 2-minute, maximal-effort push-up event, a 2-minute, maximal-effort sit-up event, and a timed two-mile run [1]
20 mSRT	20-m progressive shuttle run test (m=meter)
ROC-curve	Receiver operating characteristic curve
ROM	Range of motion
CR10	The Borg CR10 scale
VAS	Visual analogue scale
OR	Odds ratio
RR	Risk ratio

SWEDISH TRANSLATIONS AND EXPLANATIONS OF TERMS

English	Swedish
Call-up, the start of the military training	inryckning
Comprehensive intervention	allsidigt åtgärdsprogram
Compulsory military service, basic training, and basic combat training	värnpliktsutbildning
Conscript, soldier, recruit	värnpliktig
Enrolment and enlistment	mönstring och inskrivning
National Service Administration	Pliktverket
Prematurely discharged or discharge	avgång
Ranger soldier, ranger unit	jägarsoldat, jägarförband
The ranger test	jägartest

Explanations of terms

Musculoskeletal	referring to the human muscle, joint and skeletal system
Disorder, pain, complaints and injury	conditions with or without a medically-based diagnosis
Functional limitation	activity limitation defined by actions [2]
Participation restriction	limitation on participation in the present context, i.e. military service.
Disability defined by activities	i.e. functional limitation in a social context [2]
Treatment strategy	strategy for treating conditions with or without a medically-based diagnosis, i.e. disorder, pain, complaints and/ or injuries
Rehabilitation strategy	strategy for overcoming disorders, functional limitations and participation restrictions
Secondary prevention strategy	strategy for preventing further symptoms and disability
Primary prevention strategy	strategy for improving the capacity of those with limitations according to the requirements of their jobs
Promotion strategy	strategy for improving the capacity for those without limitations according to the job requirements

1 BACKGROUND

1.1 INTRODUCTION

The tasks and capabilities of the Swedish Armed Forces are changing to meet new threats all around the world. Earlier, the most important task was to protect our borders against armed attack. Our mission-based forces now need to be ready for deployment anywhere in the world to maintain peace agreements, which includes the protection of civilian populations in war-torn regions. Defence of Sweden against attack remains an important task [3;4].

Transformation from an invasion-based national defence to much smaller, highly mobile and more specialised forces with an international focus has resulted in decreased intakes, from approximately 40 000 enlisted personnel in 1990 [5] to 5 000-10 000 per year [6]. With the sharp decrease in the number of enlisted soldiers, selection – putting the right man in the right place – is more important than ever. It is also important to prevent our conscripts from leaving military service prematurely i.e. from being discharged. The present work has sought to deepen our knowledge in this important field.

The Swedish military system is based on compulsory conscription. The Swedish National Service Administration handles pre-enlistment examinations, i.e. enrolment, and enlistment into military programs. Enrolment takes place one-to-two years before military service, Figure 1, and includes medical, psychological, theoretical and physical tests [6]. If a candidate is considered medically or psychologically unfit for compulsory national service, he will not be enlisted. In spite of this selection, in recent years 11.9 % - 15.1 % of soldiers have been prematurely discharged from the Swedish Armed Forces army units [6]. The problem of premature discharge does not exist only in Sweden, it has been reported in several studies from other armed forces [6-15]. Premature discharge results in decreased military readiness and increased costs and problems for society as well as for the soldier himself or herself [11;12;16].

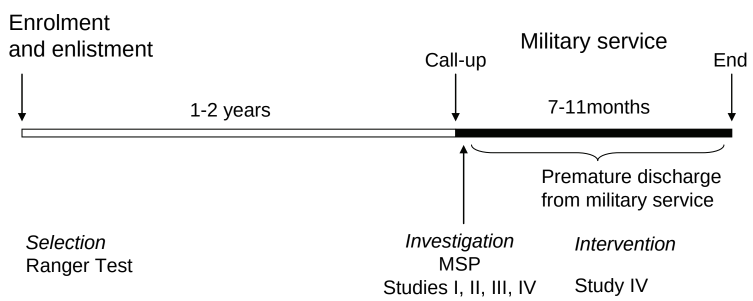

Figure 1. Enrolment and enlistment into military service and the present studies in relation to the time-line. (Modified from figure in study III, Larsson et al, 2009, Military Medicine: International Journal of AMSUS)[17].

1.2 MILITARY SERVICE

At present, military service in Sweden consists of two periods totalling around eleven months. The soldier may serve for a third period of training on international missions[3]. The third period has been introduced since the time when the material underlying the present four studies was collected. While physical demands during military service depend on the trade to which the soldier is allotted, the first three months include much physical training, demanding exercises [18] and military instruction for all soldiers. The tasks facing newly-called-up conscripts in the Swedish Armed Forces may be compared with circumstances reported from the US army, with much heavy lifting and carrying of body armour, weapons and combat equipment [19-21] and long marches [22]. It is reasonable to fear that this load-bearing can result in negative consequences for those who are not physically fit and prepared. Most soldiers start their military service after many years at school [19]; thus it is important that loads increase gradually during the first part of the service [23]. Strategies are needed for establishing soldiers' capacities or limitations at the time they report for duty.

Heavy lifting and carrying of equipment is not a new phenomenon in armed forces around the world. The Roman legions seldom carried more than 15 kg [24]. In 1921 Lothian [25] pin-pointed the problem of two conflicting demands on combat soldiers: they had to carry heavier equipment than formerly and at the same time meet demands for increasing mobility. A 1923 report [26] attributed the problem of overloaded soldiers who risked becoming physical wrecks before reaching the front partly to increasing urbanisation. Young city dwellers had lower capacity in strength and endurance than earlier vintages of farmers' sons. The German infantryman in the Second World War carried about 25 kg [27]. This may be compared to US Rangers during the Kuwait war, who had to carry about 55 kg [24]. Despite long-term recognition of the overloaded soldier, the problem still exists. In military operations there may still, despite technological development, be heavy loads for soldiers: thus for instance carrying loads of up to 120-pounds, about 55 kg, for several days has been reported from operations in Afghanistan [28].

The question is whether soldiers nowadays have to carry more then ever before? In 2003 the year before the present Study IV, we measured loads carried by the conscripts in one unit during their first field training, i.e. after the first two weeks of military service. We measured ten soldiers' body weight and the weights of their 'light' and 'heavy' backpacks, Figure 2. Their battalion commander commented that "they *only* had to carry the 'heavy' backpack during a 15-km march". The 'heavy' backpack weighed 55 kg and the lightest soldier weighed 61 kg. This signifies that conscripts during ranger training – the 'toughest' branch in the Swedish Armed Forces – are extremely loaded even early on in their training. Not all Swedish conscripts are subjected to this extreme type of physical load, however.

A change is involved for anyone moving civilian life to military training. Physical, mental and social equipment is needed to manage the training that is to prepare the individual for posting to trouble-spots the world over. "We have to train as we fight" is one important conclusion drawn by Lieutenant Colonel Kim Kristensen, Danish commander with experience of the physical demands and training preparation for ISAF personnel in Afghanistan [29]. This presupposes that account is taken of the individual's capacity, so that load injuries are avoided during this preparatory training. One starting point for the work reported in this thesis has been to prevent unnecessary load injuries by adapting and dosing the load on each soldier during his or her training.

1.3 PREMATURE DISCHARGE

Premature discharge from military service is the main outcome addressed in the present thesis. The term *premature discharge* refers to exit from military service before completion thereof [6]. Discharge is not always attributable to one single, unambiguous factor [30]. This makes classification difficult [14;30], as discussed in several studies [12;14;30;31] and by the Swedish National Service Administration [6].

Booth-Kewley et al [12] report that similar predictors associated with different categories could involve problems of overlap and ambiguity in the discharge code. Niebuhr et al [14] concluded that the extent to which medical and health factors are involved in early discharge would be underestimated using existing databases. Larson et al [31] found that psychological reasons for discharge from US Navy basic training were often classified under other administrative categories. Also, fairly many physical symptoms were given as indicators of depression or anxiety. One way to avoid such problems when examining the operational value of a screening tool is to focus on overall discharge, as suggested by Larson et al [30].

An important challenge is to develop appropriate strategies to prevent premature discharge from military service [12;16;20;30;32]. At the turn of the twentieth century, risk factors for premature discharge were investigated in several armed forces [7-15;32-36] explored below in 1.3.1**.** We do not know, however, whether their results may be generalised to the Swedish Armed Forces.

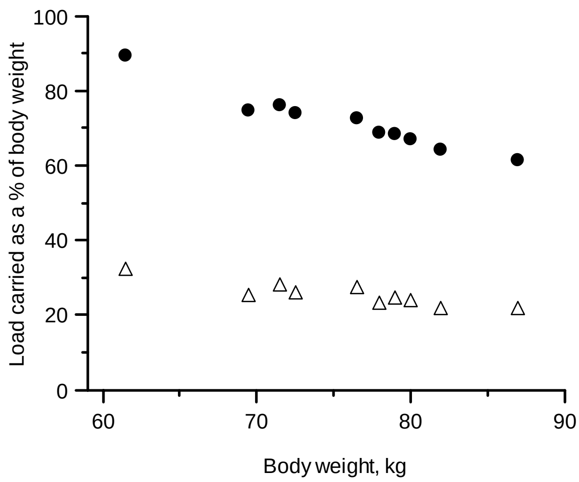

Figure 2. Load carried as a percentage of body weight in ten ranger conscripts.

1.3.1 Risk factors

1.3.1.1 *Musculoskeletal complaints or injuries*

There is consensus among several studies on increased risk of premature discharge and musculoskeletal injuries during service [9-12;14;32;34;37], Table 1. A medical condition prior to service [38;39], for example a knee condition [10] or back-related disease [33;40;41] is also important to identify, as earlier injuries increase the risk of a new injury during training, and may result in premature discharge. Whether musculoskeletal complaints or injuries *present at the start* of military service increase the risk of discharge is not clear.

1.3.1.2 *Physical factors*

Earlier studies have shown that low results on muscle endurance tests are associated with premature discharge [7,11] as is low aerobic fitness [7;9;11;15].

The risk of *musculoskeletal injury* during military service, Table 2, is greater for soldiers who assessed themselves as physically unfit [33], inactive [38;42], or untrained [43]. Those with low scores in muscle endurance tests [7;38;44] and low maximal strength in the leg-press test [45] also ran an increased risk of injury.

Studies of low aerobic capacity show an association with increased risk of musculoskeletal injury [7;9;15;38;44;46;47]. However, this contradicts results in a study by Mattila et al [48] who found increased odds ratios for lower-limb injury among those with excellent aerobic fitness. Reynolds et al [20]observed no significant relationships between injuries and low aerobic capacity.

1.3.1.3 *Mental, emotional and social factors*

In a study by Cigrang et al [8] air force recruits discharged for mental-health reasons often had a history of depression and expressed a lack of motivation to continue in the military. A history of depression/excessive worry was one of the strongest predictors of discharge for navy recruits [12]. The findings indicate that additional work is needed to identify recruits at risk. These results tally with those of Hoge et al [36] who found an association between mental disorder and medical discharge. Among other risk factors, Lincoln et al [32] identified lower job satisfaction, a modifiable factor and a possible target for intervention.

1.3.1.4 *Personal factors*

A survey of air force recruits by Klesges et al [35] found that the best single predictor of early discharge was smoking habits. The authors pointed out, however, that tobacco use could be a marker of underlying characteristics that increase an individual’s risk. Similar results have been discussed by Booth-Kewley et al [12], Lincoln et al [32] and Haddock et al [49]. There is an association between training-related injuries and smoking [7;22;38;46;47]. Based on their results Snoddy and Henderson[7] proposed that cigarette smoking is a negative factor in selecting trainees. There are, however, contradictory results [20;39].

Poston et al [13] found an association between low BMI (kg/m^2) <18 and high BMI>25 and discharge from the U.S. Air Force during the first three months. In a study of British Army soldiers [15] no other anthropometric measures than low BMI were a significant risk factor for injury. If this indicates, as discussed by the authors, that soldiers with higher BMI are better equipped to sustain the physical demands of army training (avoid injury), it is important to study this factor (body size, greater body mass) from a selection perspective; especially selection to physically demanding units. However, those authors' results contradict those of earlier studies associating increased injury risk with high BMI >25 [20;33] and overweight BMI>30 [48]. It may be that BMI is a 'blunt' instrument for classifying overweight since, within certain limits, BMI may reflect well-developed musculature.

Table 1. Risk factors for premature discharge from military service.

	Authors/ year/country	**Type of unit/ population**	**Study design**	**n**
Musculoskeletal				
Previous injury history	Niebuhr et al [14] 2006 USA	Army discharged recruits	Retrospective	2 889
Previous knee condition	Cox et al [10] 2000 USA	Army, Air Force and Navy recruits	Retrospective	1 124
Injury during the service	Heir & Glomsaker [37] 1996 Norway	Army, Navy, Air Force conscripts	Prospective	6 488
	Pope et al [9] 1999 Australia	Army recruits	Prospective	1 317
	Booth-Kewley et al[12] 2002 USA	Navy recruits	Retrospective	66 690
	Knapik et al [50] 2001 USA	Army injured recruits	Retrospective medical records	1 230
Back-related disorder	Feuerstein et al [34] 1997 USA	Army disability cases	Retrospective	41 750
Recurrent hospitalisation	Lincoln et al [32] 2002 USA	Army hospitalised personnel	Retrospective	15 268
Physical factors				
Low muscle endurance (APFT test)	Snoddy&Henderson[7] 1994 USA	Army recruits	Prospective	649
	Knapik et al [50] 2001 USA	Army injured recruits	Retrospective medical records	1 230
Low score on 20 mSRT	Pope et al [9] 1999 Australia	Army recruits	Prospective	1 317
Low cardiovascular endurance (2-mile run)	Snoddy&Henderson[7] 1994 USA	Army recruits	Prospective	649
	Knapik et al [50] 2001 USA	Army injured recruits	Retrospective medical records	1 230
Slow run time (2.4-km)	Blacker et al [15] 2008 UK	Army recruits	Retrospective	11 417
Psychological factors				
Depression/ excessive worry	Booth-Kewley et al[12] 2002 USA	Navy recruits	Retrospective	66 690

Table 1. Continuation.

	Authors/ year/country	Type of unit/ population	Study design	n
Mental health condition	Niebuhr et al [14] 2006 USA	Army discharged recruits	Retrospective	2 889
Depression Lack of motivation	Cigrang et al [8] 1998 USA	Air Force recruits	Descriptive	1 138
Mental disorder	Hoge et al [36] 2005 USA	Army hospitalised soldiers	Retrospective medical records	13 971
Low education level	Knapik et al 2001 USA	Army injured recruits	Retrospective medical records	1 230
	Booth-Kewley et al[12] 2002 USA	Navy recruits	Retrospective	66 690
Lower job satisfaction	Lincoln et al [32] 2002 USA	Army hospitalised personnel	Retrospective	15 268
Life style factors				
BMI <18 or >25	Poston et al [13] 2002 USA	Air Force airmen	Retrospective	32 144
Smoking	Snoddy&Henderson[7] 1994 USA	Army recruits	Prospective	649
	Klesges et al 2001 [35] (Tobacco Control)	U.S. Air Force recruits		29 044
	Booth-Kewley et al[12] 2002 USA	Navy recruits	Retrospective	66 690
	Lincoln et al [32] 2002 USA	Army hospitalised personnel	Retrospective	15 268
Extrinsic factors				
Greater work stress	Lincoln et al [32] 2002 USA	Army hospitalised personnel	Retrospective	15 268
Heavier physical job demands	Feuerstein et al [34] 1997 USA	Army disability cases	Retrospective	41 750
High load exposure	Lincoln et al [32] 2002 USA	Army hospitalised personnel	Retrospective	15 268

Different risk factors associated with premature discharge have been identified from different armed forces. However, most of the relevant research comes from the USA. The results signify the need for systematic identification of high-risk personnel with routine surveillance systems to prioritise prevention and treatment [16]. Though many risk factors have been identified, we need to see whether others should be included in the prioritisation of interventions. It is also unknown whether earlier-published results can be generalised to the Swedish Armed Forces, where selection procedures for military service differ from those in the US.

Theoretically, primary prevention would be the most effective strategy, working before injuries or mental disorders occur. However injuries are common in military populations, hence both primary and secondary prevention strategies are important.

Table 2. Risk factors for musculoskeletal injury during military service.

	Authors/ year/ country	Type of unit/ population	Study design	n
Musculoskeletal				
Previous injury history	Jones et al [38] 1993 USA	Infantry trainees	Prospective	303 male
	Schneider [39] 2000 USA	Army and airborne soldiers	Retrospective	1 214
Previous knee condition	Cox et al [10] 2000 USA	Army, Air Force and Navy recruits	Retrospective	1 124
Back-related disease	Mattila et al [41] 2008 Finland	Conscripts from ten garrisons	Cross-sectional	7 040 male
Back pain prior to service	Hestback et al [40] 2005 Denmark	Recruits	Prospective Cross-sectional	1 711
Dysfunction of back or limb	Heir & Eide [33] 1996 Norway	Air Force conscripts	Prospective	912 male
Self-perceived health, (below-average)	Mattila et al [41] 2008 Finland	Conscripts from 10 garrisons	Cross-sectional	7 040 male
Physical factors				
Self-assessed low fitness	Heir & Eide [51] 1997 Norway	Conscripts	Prospective	480 male
Inactive, work and leisure time	Morken et al [42] 2007 Norway	Navy workers	Cross-sectional	2 265
Untrained	Rosendal et al [43] 2003 Denmark	Life guard basic training	Prospective	330 male
Low level past physical activity	Jones et al [38] 1993 USA	Infantry trainees	Prospective	303 male
Low maximal strength (leg)	Hoffman et al [45] 1999 Israel	Basic training,	Prospective	136 male
Low muscle endurance	Knapik et al [44] 1993 USA	Infantry training	Prospective	298 male
(APFT)	Jones et al [38] 1993 USA	Infantry trainees	Prospective	303 male
	Snoddy&Henderson[7] 1994 USA	Infantry	Prospective	649
Low aerobic capacity	Knapik et al [47] 2001 USA	Army basic combat training	Prospective	1 230
Low score on 20 mSRT	Pope et al [9] 1999 Australia	Army recruits	Prospective	1 317 male
Slow run time (2-mile-run)	Knapik et al [44] 1993 USA	Infantry training	Prospective	298 male

Table 2. Continuation.

	Authors/ year/ country	Type of unit/ population	Study design	n
Slow run time (2-mile-run)	Jones et al [38] 1993 USA	Infantry trainees	Prospective	303 male
	Snoddy&Henderson[7] 1994 USA	Infantry	Prospective	649
	Reynolds et al [46] 1994 USA	Light infantry unit	Prospective	181
Slow run time (2.4-km run)	Blacker et al [15] 2008 UK	Army recruits	Retrospective	13 417
Psychological factors				
Mental health	Heir & Eide [33] 1996 Norway	Air force conscripts	Prospective	912 male
Life style factors				
BMI <22	Blacker et al [15] 2008 UK	Army recruits	Retrospective	13 417
BMI >25	Reynolds et al [20] 2002 USA	Engineers and artillery soldiers	Prospective	313
	Heir & Eide [33] 1996 Norway	Air force conscripts	Prospective	912 male
BMI >30	Mattila et al [48] 2007 Finland	Conscripts	Register data	135 987
Smokeless tobacco (snuff)	Heir & Eide [33] 1997 Norway	Conscripts	Prospective	480 male
	Mattila et al [41] 2008 Finland	Conscripts from 10 garrisons	Cross-sectional	7 040 male
Smoking	Jones et al [38] 1993 USA	Infantry trainees	Prospective	303 male
	Reynolds et al [46] 1994 USA	Light infantry unit	Prospective	181
	Reynolds et al [22] 1999 USA	Light infantry	Prospective	218 male
	Snoddy&Henderson[7] 1994 USA	Army Infantry	Prospective	649
	Knapik et al [47] 2001 USA	Army basic combat training	Prospective	1 230
Extrinsic factors				
Vigorous physical training weight bearing	Almeida et al [23] 1999 USA	Marine Corps recruit	Prospective	1 296

1.3.2 Preventive intervention

In contrast to the literature on risk factors for premature discharge, few studies investigate its prevention and here the results conflict [1;52-55]. Inconsistencies in the results of studies targeting the prevention of premature discharge may have several explanations. Designs and methods of collecting and recording data differ. Hence, no standard intervention method, gold standard, has been suggested for military populations. Both primary and secondary strategies have been investigated.

Rehabilitation is one suggested strategy for reducing premature discharge. U.S. Soldiers *injured during basic* combat training were assigned to a Physical Training and Rehabilitation Program [56]. While a high discharge rate was established for those participating in the programme, the overall discharge rate among those who continued after the rehabilitation resembled that among those with no need for rehabilitation. The results agree with those of an earlier investigation by Kelly and Bradway [52]. Here, a team approach to treating musculoskeletal injuries was effective in reducing discharge due to musculoskeletal disorders. However, the overall discharge rate increased.

Petersen and Smith [54] documented the benefit of musculoskeletal medical screening of soldiers who failed the physical fitness test or had an injury. Injured soldiers were referred to and received medical intervention. The results conflict with those of Berg et al [53], who questioned the effectiveness of an initial screening process. Their study comprised screening, referral, and intervention. The screening correctly identified those needing medical intervention but did not affect the number of discharges.

Williams et al [55] conducted a mental health intervention for navy recruits during basic training. Significantly more recruits in the intervention division completed the training than in the control division. The conditions for navy recruits may differ from those of army conscripts during basic training, and the programme would need to be tested with other armed service populations to examine its generalisability.

A retrospective study of physical outcomes found that the discharge rate decreased significantly in women but not in men after a primary prevention strategy had been implemented for improving the fitness level of new soldiers before basic training [50]. Another study [1] showed that the discharge rate decreased significantly in both sexes when soldiers were ‘preconditioned’ before basic training.

Implementation of a modified physical training concept decreased *the risk of overuse injuries* in an experimental group of U.S. army soldiers compared to a historical control group [57]. An injury reduction programme with modified physical training, injury education, and injury surveillance systems also reduced injuries [58]. These studies did not evaluate outcome in terms of discharge. The results conflict with those of a randomised controlled trial with 1020 army soldiers where a prevention programme did not influence the risk of lower-leg-overuse syndrome [59]. The programme consisted of five exercises for strength, flexibility and co-ordination, for 15 minutes three times a week.

Several studies from the U.S. Army during the past few decades have used the Army Physical Fitness Test (i.e. the army’s physical standard) for evaluating muscular strength/ endurance. However, the sit-ups and push-ups involved are not strongly associated with soldiering capacity or other military job performance [57]. Other physical tests might well complement the testing procedure in the future.

Heavy physical job demands [34], (certain occupations associated with higher disability risk), high load exposures [20;32] and greater work stresses [32] have been investigated. The results demonstrate the importance of investigating specific workplace exposure (biomechanical, metabolic and psychosocial) as demanding job requirements can result in disorders and disability.

Individual physical ability/capacity in relation to physical demands during military training is one of several factors that are decisive for managing the service [60;61]. The physical demands on the individual in various occupations during conscript training in Sweden have not been identified. For enrolment, an isokinetic lift test (Isokai, M-produkter, Norsborg, Sweden) is used at present. This ranks testees by result. This means that those with the best results, measured in Newtons, may be enlisted in the trades considered to be the most physically demanding. The work reported in the present thesis was initiated to supplement the existing strength test with a relevant task-related occupational test for the most physically demanding units – the rangers – in this way raising the selection requirements for this group of conscripts.

Another reflection is that present studies from U.S. military population have changed the focus from measuring physical capacity to investigating musculoskeletal disorders. This was discussed by Zambraski of the U.S. Army Research Institute of Environmental Medicine, Natick, during the 2008 MNILK conference [62].

Assuming that those qualifying for Swedish military service have been selected and enlisted, one question remains: are there still factors present one-to-two years later when service usually starts that could constitute risks of premature discharge?

1.4 THEORETICAL FRAMEWORK AND MAIN PERSPECTIVE

To give an overview of the process in a comprehensive intervention, a figure was developed by the author: ‘the ability process’, Figure 3. A person can be without disorder but suffer a functional limitation in relation to the requirements of his or her job, for example inadequate muscle performance or a tight quadriceps muscle [63]. Alternatively, if physical demands increase e.g. at the start of conscription, a previously asymptotic abnormality can become symptomatic [18]. This signifies a gap between personal capacities and environmental demands e.g. job requirements, and may result in an overuse disorder or injury. It is therefore important to identify disorders and/ or functional limitations at the time conscription begins.

‘The ability process’ is based on ‘the disablement process’, a conceptual scheme in social, medical and public-health science which guides terminology, measurement and hypothesis formation. It was extended from the ICIDH and the Nagi schemes by Verbrugge and Jette [2]. These three schemes follow the same direction of the main pathway of pathology and its functional consequences. Starting with ‘disease’ (in the ICIDH scheme) or ‘active pathology’ (in Nagi’s and Verbrugge’s & Jette’s schemes) the main pathway is ‘impairment – disability – handicap’ (ICIDH) or ‘impairment – functional limitation – disability’[2;64]. ‘The disablement process’, especially useful for research design, was extended by introducing factors that “speed or slow disablement” i.e. personal and environmental factors [2]. However, if disablement is seen as a continuum resulting from pathology [2;65] we lose the opportunity to study the interaction of function and pathological processes as discussed by Thornquist [66] due to network interactions between variables.

The present assessments/measures were designed to detect disorders and functional limitations and to make both the individual and his instructors aware of early signs of disorder and functional limitation. The individual's function in an environment is meaningfully understood and estimated only in terms of his fulfilment of the roles and tasks he is called upon to do. A commonly observed phenomenon, however, is that two persons' ratings, e.g. of 'similar' back pain, may have different manifestations in limited role function; or two patients with the same injury may have considerably different outcomes [65;67]. The context – here type of unit – may play a role in differing outcomes, and this is important to consider when interpreting data.

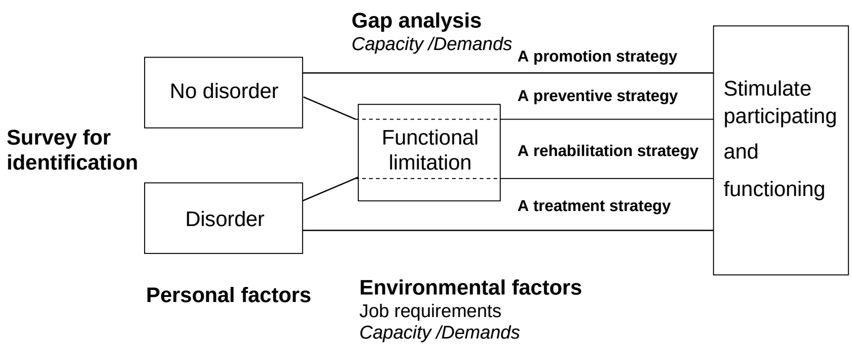

Figure 3. 'The ability process'.

1.4.1 Physiotherapy

The physiotherapists' contributions were of major importance in the present interventions. As outlined at the 14th General meeting of the World Confederation of Physical Therapy WCPT, May 1999, physiotherapy "is concerned with identifying and maximising movement potential, within the spheres of promotion, prevention, treatment and rehabilitation"[68]. The physical therapy process includes assessment, diagnosis, planning, intervention and evaluation. The present work included all three purposes of physiotherapy: promotion, prevention and intervention, Figures 3 and 4.

1.4.2 Identifying and clarifying the measurement objective

The instruments and questionnaires employed are presented in a three-dimensional model schematically described in the cube, Figure 4. The cube was modified from Turner's model [69]. The measurements cover physical, mental, emotional and social assessment in a discriminative and predictive approach [70]. The three levels of assessment are disorder, functional limitation and participation restriction.

The measurements in the first study were intended for use in determining cut-off values in a test predicting whether conscripts would complete their training: it was an attempt to classify individuals pending the advent of a gold standard [70]. This reflected an *a priori* approach [64]: establishing criteria task standards for military ranger service.

In the following three studies the goal of the measurements was to detect differences between subjects at a single point of time [70], discriminating those who needed interventions. In an *a posteriori* approach [64] specific measures are used together in a battery to obtain a comprehensive picture of different areas of primary interest [67]. This could be a step towards more effective methods of reducing the gap between an individual's functional capacities and the demands of his environment. Awareness of its members' disorders and/ or functional limitations will help an organisation to target intervention strategies to stimulate functioning and participation and avoid disability, Figure 3. In the worst case, disability resulting in participation restriction will lead to premature discharge from military service.

The individually- and organisation-based interventions included treatment, rehabilitation and preventive strategies. To optimise the individual's potential to assimilate training, the intervention also included health promotion, Figure 3.

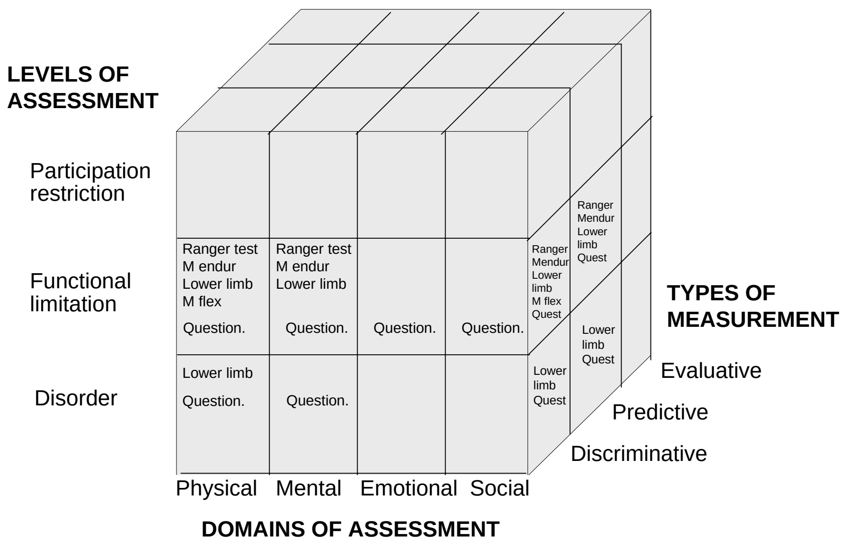

Figure 4. The assessments /measurements (questionnaire, lower-limb-loading tests, muscle flexibility, muscle endurance tests and ranger test) schematically described in a cube modified from Turners' model.

Denegar et al [65] describe disability as the gap between a person's capabilities and his expectations. Where disability is regarded as an individual-centred experience, self-reports of function are important outcomes to measure. In the present case however, disability includes *officers'* expectations of individuals: the gap lies between military tasks and conscripts' capabilities. Whether it is the individual himself or his surroundings/superiors that set the demands higher than his capability, the risk of overloading is evident.

1.5 RATIONALE

Different risk factors for premature discharge from military service have earlier been identified. It was however, unknown whether those findings could be generalised to the Swedish Armed Forces. With the clinical experience of a high prevalence of musculoskeletal complaints or injuries (MSCI) in military conscripts, an important question was whether MSCI *present at the start* of military service also increase the risk of premature discharge. Another clinical experience, supported by reports from the Swedish National Service Administration and by the Conscripts' Council, was that many conscripts were required to carry heavy loads and also that they were dissatisfied with their physical exercise and preparation during the training [71].

There is general agreement in the literature that it is important to implement appropriate preventive strategies in military service. So far, the beneficial effects on premature discharge outcome of a method including selection before military service and a comprehensive intervention during the service are still unknown. The intention of the work reported here was to investigate the problem of premature discharges from two directions – selection and intervention.

2 OVERALL AIMS

The overall aim of the present work was to identify risk factors for, and to describe and analyse the influence of preventive interventions on, premature discharge from military service compared to earlier years.

2.1 SPECIFIC AIMS

The objective of Study I was to evaluate the predictive capacity of a lower-limb functional capacity test, the ranger test, on premature discharge from strenuous military ranger training and to establish a minimum performance standard to be used at enrolment by the Swedish National Service Administration.

Study II aimed at evaluating the screening capacity of the four lower-limb-loading tests designed to detect knee pain and to predict discharge from military training. An additional aim was to examine the reproducibility of the pain ratings during the tests.

The aim of study III was to investigate the prevalence of musculoskeletal complaints or injuries and individual risk factors leading to premature discharge from conscript service.

In study IV, the aim was to describe and analyse the influence on premature discharge of implementing a specially-tailored comprehensive intervention programme for the Swedish Armed Forces. We also wished to know whether predictors of discharge could be identified even though an intervention had taken place.

3 METHODS

3.1 DESIGN

All four studies presented here have a longitudinal cohort design.

3.2 SUBJECTS AND PROCEDURE

Male conscripts from different army units participated in the four studies during their military service. The cohorts[1] included are presented in Table 3 and the subjects' characteristics in Table 4.

An additional 31 conscripts were recruited to investigate the reproducibility of the muscle endurance tests (unpublished data).

Exclusion criteria and dropouts
Altogether 1848 conscripts started their military service in the units studied. Of these, 2.3% were excluded or non-participants, Table 3. Women were excluded because they were so few (1.0%). Since conscripts with hearing impairment may not remain on the course even if they want to, they were excluded from the predictive analyses (0.4%) (Studies III, IV). Those who were unavailable for testing at the start of military service (sick-listed or absent 0.5%), or declined participation (0.4%), were categorised as dropouts. Thus, altogether 1807 conscripts participated.

Table 3. Subjects and different cohorts in the thesis.

Year	Unit	Total	Drop out	Ex-cluded	Study I	Study II	Study III	Study IV	Thesis
		n	n	N	N	n	n	n	n
1997	Ranger	38			38				
1998	Ranger	288	3 [a]		285				
2002	Artillery	608							
			7 [b]	11 [c]		590			
			7 [b]	10 [c]			469		
2003	Artillery	120		5 [c,d]				115 [A]	
2003	Ranger	31							31
2004	Ranger	356							
			12 [a]			258			
			2 [a]	2 [c,d]				352 [A,B]	
2004	Engineer	407	5 [a]	7 [c,d]				395 [B]	
Included					323	848	469	862	31

a) sick-listed
b) declined participation
c) women
d) hearing impairment

A) intervention 'as planned'
B) 'less intensive' intervention

[1] *Cohort originally = 300-600 men = 1/10 of a Roman legion. In demography: group of persons with a common statistical characteristic (OED).*

Table 4. Subjects' anthropometric data.

Study	Subjects n	Age, years Mean (SD)	Weight, kg Mean (SD)	Height, m Mean (SD)	BMI, kg/m^2 Mean (SD)
I	38	20.7 (0.8)	80 (7)	1.81 (0.06)	24.6 (1.7)
	285	20.6 (0.8)	75 (7)	1.81 (0.06)	23.0 (2.0)
II	590	19.4 (0.6)	77 (13)	1.81 (0.07)	23.6 (3.7)
	258	19.4 (0.6)	79 (8)	1.82 (0.06)	23.9 (2.1)
III	469	19.3 (0.5)	77 (14)	1.80 (0.07)	23.7 (3.8)
IV	862	19.3 (0.6)	77 (11)	1.81 (0.06)	23.7 (3.0)
Thesis	31	20.5 (1.1)	77 (8)	1.81 (0.06)	23.5 (1.2)

The investigations and assessments were applied within the first week of the conscripts' military service, i.e. one-to-two years after initial enrolment, except for 38 ranger conscripts participating in study I. Cases of premature discharge were recorded during service.

In Study I, 38 ranger conscripts who had succeeded in their training were assessed with a maximal muscle endurance test battery, including maximal numbers of repetitions of the ranger test *at the end of* their military service. Based on the results from the first part of the study, ranger conscripts (n=285) from the next annual intake in the same unit were tested with a submaximal ranger test.

In study II, 848 subjects, 590 artillery conscripts and 258 ranger conscripts, completed a questionnaire regarding musculoskeletal complaints or injuries and were assessed/tested with the four lower-limb-loading tests. Artillery conscripts were individually tested while ranger conscripts were tested in groups of 25 to 45. The ranger conscripts were also assessed on two occasions approximately two hours apart at the end of their military service to examine the reproducibility of the four lower-limb-loading tests.

Study III covered 469 of the artillery conscripts included in Study II and who started their training in June or in August; but those who started in January were excluded. Information on the prevalence of musculoskeletal complaints or injuries, life-style factors, self-rated health, motivation, and preparedness for military service was collected via a questionnaire especially designed for the study. Knee pain during the four lower-limb-loading tests, muscle flexibility and isometric muscle strength were also assessed. The muscle strength test was performed twice within two hours by 427 of the conscripts to examine its reproducibility.

Study IV, (n=862) comprised 115 artillery conscripts, 395 engineer conscripts and 352 ranger conscripts (of whom 258 rangers had also taken part in Study II). After investigation with a musculoskeletal screening protocol comprising the questionnaire and tests in study III, an intervention procedure started. This was continued until the end of the conscripts' military service. They answered a questionnaire regarding physical exposure three months after the start of the intervention procedure analyse whether physical exposure differed between the army units.

3.3 MEASUREMENTS AND ASSESSMENTS

The variables, measuring method and domain (Figure 4) of measurement are summarised in Table 5.

3.3.1 Anthropometric measurement

Body weight (kg) and height (m) were measured and body mass index, BMI (kg/m^2) was calculated. Four categories were used: BMI <18.5, 18.5-24.9, 25.-29.9, $\geq$30 [72].

3.3.2 The ranger test

The ranger test is a submaximal muscle endurance step-test of lower-limb function developed by H.L for selection to strenuous military ranger training. For the test the subject wears a 20-kg backpack and with one foot on the bench (0.4-m high) steps onto and down from the bench with the other leg, 80 times. The procedure is then repeated with the other leg.

3.3.3 Musculoskeletal screening protocol

Based on clinical experience and results from earlier research on risk factors for military service, a musculoskeletal screening protocol (MSP) with the main purpose of identifying personnel at risk of premature discharge was developed. The MSP comprised a questionnaire, a lower-limb-loading test with pain-intensity ratings, assessment of passive muscle flexibility, and muscular endurance tests.

3.3.3.1 *Questionnaire*

The questionnaire developed by H.L. covered the occurrence of musculoskeletal complaints or injuries in ten anatomical locations, life-style factors and experience of motivation and preparedness for military service. It was first tested in a pilot study of 578 newly-called-up conscripts in an army unit in 2001. Some fairly small adjustments were made thereafter and the questionnaire was tested again with newly-called-up conscripts in the same unit the next year (Study II). For the subsequent call-ups in June and August 2002 (Study III), the questionnaire was further supplemented with questions covering self-rated health. These supplementary questions were originally designed for investigating the health of Swedish Air Force fighter pilots [73]. To assess the perceived intensity of reported musculoskeletal complaints or injuries (MSCI), the questionnaire was supplemented with a 100-mm visual analogue scale (VAS), whereupon it assumed its present form covering physical, mental and emotional domains (APPENDIX 1, the Swedish version).

Leisure time physical activity was assessed using two questions scored on a five-point scale, with response alternatives ‘never’, ‘irregularly’, ‘once a week’, ‘twice a week’, and ‘three times a week or more’. The answers to each question were scored 0-4 (0=never). Responses to the two questions were then combined into four categories i.e. physically inactive, low, medium and high physical activity.

The reproducibility of the questions was established in a 14-day test-retest with 28 conscripts, (Study III). The reproducibility of the binominal questions indicated a good-to-excellent percentage agreement (73.9-100%). Questions eliciting self-rated health had seven possible answers ranged from ‘very poor’ to ‘excellent, cannot be better’. The answers were coded into three groups: bad, good and excellent. The reproducibility calculated with weighed k statistics ranged from 0.26 to 0.51.

Table 5. The variables measured throughout the work.

Variables	Measured using	Domain	Study			
			I	II	III	IV
Body Mass Index	Weight/height (kg/m^2)	Personal factor	•	•	•	•
Musculoskeletal complaints or injuries in knee (MSCI)	Questionnaire Yes/No	Physical		•	•	•
MSCI 10 anatomical locations	Questionnaire Yes/No	Physical			•	•
Perceived intensity	Visual Analogue Scale	Physical/ mental				•
Leisure-time physical activity level	Questionnaire	Physical			•	•
Muscle stretching habits	Questionnaire Yes/No	Physical			•	•
Food habits	Questionnaire Yes/No	Personal factors			•	•
Cigarette smoking	Questionnaire Yes/No	Personal factors			•	•
Snuff-taking	Questionnaire Yes/No	Personal factors			•	•
Mentally prepared	Questionnaire Yes/No	Mental			•	•
Physically prepared	Questionnaire Yes/No	Physical			•	•
Motivation	Questionnaire Yes/No	Emotional			•	•
Perceived self-rated health:						
Physical health	Questionnaire	Physical			•	•
Mental health	Questionnaire	Mental			•	•
Physical environment	Questionnaire	Environmental			•	•
Social environment	Questionnaire	Social			•	•
Working capacity	Questionnaire	Physical, mental, emotional, social			•	•
Knee pain intensity	Borg CR10 rating during 4 lower-limb tests	Physical/ mental		•	•	•
Muscle flexibility						
rectus femoris	ROM	Physical			•	•
hamstrings	ROM	Physical			•	•
iliopsoas	ROM	Physical			•	
gastrocnemius	ROM	Physical			•	
soleus	ROM	Physical			•	
Isometric endurance						
Back muscle	Sorensen test	Physical/ mental				•
Dynamic endurance						
Muscles upper extremities	Chins	Physical/ mental				•
Muscles upper extremities	Push-ups	Physical/ mental				•
Trunk muscles	Sit-ups	Physical/ mental				•
Muscles lower extremities	Ranger test*	Physical/ mental	•			
Maximal strength (N)						
Lift performance	Isokai test*	Physical/ mental			•	
Data from enrolment test						
Maximal strength (N)						
Lift performance	Isokai test*	Physical/ mental			•	•
Physical exposure	Questionnaire	Environmental				•

* not included in the musculoskeletal protocol (MSP)

3.3.3.2 *Lower- limb-loading tests with pain-intensity ratings*

The four lower-limb-loading tests were intended to identify knee disorders, including those of which the individual may not previously have been aware. Pain intensity in the knee was rated during the tests using the Borg CR10 Scale (CR10) [74;75]. For each test, five repetitions were performed with each leg before the next test was started, in the test order described below. After every set of five repetitions, the highest self-rated pain intensity in the knee, if any, was reported. The instruction for the test is given in APPENDIX 2, (Swedish version).

The Borg CR10 Scale (APPENDIX 3, Swedish version) was chosen for pain-intensity rating because it is reliable for assessing intensity of perceived pain in loaded joint structures [76] – and for ease of administration, the subject merely saying a number and an assistant entering it in a protocol. Subjects were given both verbal and written instructions regarding the use of this scale.

The step-up test was modified from the ranger test [77] (i.e. without a 20-kg backpack). The lower-limb-loading tests are intended to identify disorders at different levels, including those of which the individual may previously have been unaware. This differs from the ranger test, a strenuous capacity test, where subjects have to pass minimum performance standards. The test was performed on a 0.4-m-high bench.

The step-down test was modified from the test described by Loudon et al [78]. In the present test the bench is 0.2 m higher than those authors' (0.4-m-high).

The test of rising from a bench (0.4-m-high) was modified from Ekdahl et al [79]. In the present form the bench is 0.05 m lower. The subject rises to standing on one leg, with the other leg stretched in front of the body and arms held in front of the body.

The bilateral squat test was modified from the test described by Purdam et al [80] and Loudon et al [78]. The subject squatted until full flexion was reached instead of 50^{o} or 90^{o} knee flexion.

The perceived-pain-intensity ratings during the lower-limb-loading tests were categorised into three groups: no pain, pain>0 to $\leq$1, and pain >1 on the CR10.

To check for time effects of fatigue, the test order was randomised on one test occasion with 258 conscripts who performed a test-retest at the end of their training (Study II). The randomisation revealed no outcome differences.

Assessment of face validity and content validity is essentially subjective and often done by a panel of experts. This was discussed and tested in a group of skilled physiotherapists. Personnel from the National Service Administration, physicians from the Swedish Armed Forces HQ, and officers from one army unit were involved in these discussions and tests, and in a review of the questionnaire.

3.3.3.3 *Muscle flexibility*

Passive range of motion (ROM) in lower limbs was measured. Foot dorsiflexion was measured in standing with straight and flexed knee, hip extension, hip flexion with straight leg, and knee flexion when prone. The measurements, test positions and reliability have been described earlier by Ekstrand et al [81]. The measurement of ROM in Study IV was, however, standardised differently. The two characteristics chosen were the flexibility of quadriceps and hamstrings. Knee flexion was measured when the subject lay prone, maximally flexing one knee at a time [82], and the distance between heel and buttock was measured by the test-leader with a ruler. For hip flexion, the test-leader estimated whether this was restricted (less than approximately 70-80 degrees) during passive straight-leg raising with the subject supine.

3.3.3.4 *Muscle endurance tests*

Three dynamic endurance tests were performed: push-ups, sit-ups, and pull-ups using a bar. This test battery has been used earlier in ranger conscription in Study I, and for Swedish paratroops since 1985 (unpublished data). A metronome marked the rate: 50 marks per minute (0.42 Hz). The test continued until the subjects were unable to keep up the pace or the test leader judged that the movement was no longer being performed according to instructions. For back extension a modified isometric endurance test [83] was performed, with maximum performance time registered.

Test-retest reproducibility was examined with 31 conscripts who performed the tests twice within 3-10 days. The test performance and measurement standardisation are detailed in APPENDIX 4 (Swedish and English versions).

3.3.3.5 *Muscle strength*

Muscle strength was measured in an isokinetic lift machine, “Isokai”. Force (*N*) was recorded during a two-handed lift of a bar in an isodynamic movement from knee level to shoulder level starting with straight, forward-inclined back and bent knees. The reproducibility of the test was examined with 427 conscripts tested twice within two hours. The mean (SD) result was 691 (116) *N*, the $ICC_{2.1}$ was 0.94, the SEM was 29.8 *N*, and the SEM% was 4.3.

3.4 COMPREHENSIVE INTERVENTION

The comprehensive intervention comprised 1) a course for officers in which personnel from the medical staff also participated, 2) the described musculoskeletal screening protocol (MSP) followed by 3) early rehabilitation, 4) organised, systematic co-operation between officers and physiotherapist, and 5) physical training programmes.

The officers’ training started with the MSP. All officers were expected to be familiar with the different tests and also aware of their own performance levels and any disorders and functional limitations. When the conscripts performed the tests at the start of their training, their officers took an active part in the MSP. This was important because one purpose of the intervention was to be able to adjust the physical training/ exercise and loading to each conscript’s capacity during his term of service, especially at the beginning. For this, the officers had to know as soon as possible which of their conscripts had any disorder and /or functional limitations.

Organised, systematic co-operation between the officers and the physiotherapist started at this time.

Knowledge of how to increase the duration, frequency and intensity of physical activities gradually [84] is essential in work like this. Besides the practical exercises outlined, the officers' training included classroom instruction. This ranged from exercise physiology and tissue adaptation to loading, load adjustment and work-related exposure biomechanics. It also included first aid for musculoskeletal injuries and principles for alternative physical loading during recovery from overuse and traumatic musculoskeletal injuries. Conscripts whose MSP identified problems were investigated individually by the physiotherapist within the first two weeks. Depending on the magnitude of the problem they were treated individually or were instructed and trained in groups. Co-operation between the physiotherapist and the officers was intensive. The officers were expected to be conversant with early signs of complaints or functional limitations. They and the physiotherapist had to exchange information continuously so as to optimise the individual's possibilities for assimilation into the service.

3.4.1 Differences in the intervention

Realities of service life, leave and unforeseen circumstances meant that not all the conscripts underwent the intervention as planned. Those who did were analysed as group A, while those for whom the intervention was less intensive were analysed as group B. In group A, *all officers* participated in the training, and a routine was worked out for weekly discussion regarding the conscripts with health conditions and their individual workload adjustment. The physiotherapist was available every day, if necessary, during the first three months. In group B, however, we failed to include all the officers in our course and the physiotherapist took four weeks' vacation starting two weeks after the conscripts' training began.

3.5 STATISTICAL ANALYSES

For an overview of the statistical methods used, see Table 6. All analyses were performed using the SPSS for Windows statistical package (version 10.0-15.0).

3.5.1 Statistical methods

Descriptive statistics
Demographic data /subjects characteristics are presented as mean and standard deviation (SD). Results are presented with median, 25^{th} and $75th^{th}$ percentiles and range (ordinal or not-normally-distributed data) or with mean and SD.

Reproducibility
Percentage agreement was used to evaluate the reproducibility (14-day test-retest) of the questionnaire in Study III (questions with nominal data). For questions with several possible answers, i.e. ordinal level, and for the reproducibility of the pain-intensity ratings in Study II, weighted-κ statistics were calculated.

The statistical analyses of muscle-endurance tests, test-retest of continuous data, started by evaluating changes to the mean using Bland-Altman plots [85]. The intra-class correlation coefficient (ICC) [86] was then calculated. This is defined as the ratio of the true variance between subjects to the total observed variance. The ICC offers a relative outcome of reliability, while the variability of the measurements offers an absolute measure, the actual size of the variability between test occasions. Values above 0.75 indicate good reliability; however, many clinical measurements should exceed 0.90 to ensure reasonable validity [86]. The standard error of measurement (SEM) is defined by SEM=√WMS where WMS is the mean square error term from the analysis of variance. To give a percentage value (i.e. SEM%) the SEM is divided by the mean of all the measurements and multiplied by 100. The typical variation is then expressed as a percentage value and can be used to interpret the data. When evaluating clinically important changes, the "smallest real difference" (SRD) may be calculated [87]. The equation is formed by multiplying the standard error of measurement by √2 and by 1.96 to include 95% of the observations of the difference between the two measurements.

Differences between two dependent groups
The Friedman two-way analysis of variance was used to study differences between the pain intensity levels (CR10) for the four tests in Study II. To examine whether there was a difference between the ratings, the Wilcoxon signed-ranks test was used. Bonferroni correction [88] was applied in Study II to the six possible comparisons, setting the α level to 0.05/6 = 0.008 [86].

Differences between two independent groups
Potential differences in the investigated variables between those who were discharged and those who stayed the course were analysed using different statistical methods depending on the levels of measurement. The chi-square test for variables was used at the nominal level in Studies I, III, and IV, the Mann-Whitney *U* test for variables at the ordinal level in Studies II, III, and IV, and the unrelated Student's *t* test for variables at the ratio level in Studies I, III and IV. Relationships between the questionnaire answers and the intensity ratings were analysed with the chi-square test in Study II. To compare the intervention groups with the historical analyses in Study IV, the chi-square test and the Mann-Whitney *U* test were used.

Significance level was set to $p<0.05$.

Association
Pearson's product-moment correlation coefficient was used in Study I to check whether body height was a confounder associated with the maximal number of receptions performed in the ranger test. Spearman's correlation coefficient (Studies III, IV) was used to indicate the degree of association between the independent variables before they were included in a logistic regression analysis.

Univariate analyses (Studies III, IV) were computed, where variables significantly associated with discharge were considered for further analysis ($p\leq0.005$). Based on the results from the univariate analyses, variables were included in multiple logistic regression (Studies III, IV). Odds ratios (OR) and 95 percent confidence intervals (95% CI) were calculated. To avoid strong multicollinearity, correlation between independent variables was investigated before inclusion in the multiple logistic regression analysis. A logistic backward elimination, (backward stepwise likelihood ratio, with criteria for entry $p<0.05$ and for removal $p>0.1$) was applied. The models were systematically checked for interactions between variables.

The *risk ratio* and 95 percent *confidence intervals* (95% CI) (Study I) were calculated as the risk of discharge from basic training for those with a performance of <80, <70, or <50 repetitions in the ranger test.

Sensitivity and specificity
To analyse the predictive value of the tests, i.e. whether those who failed the ranger test (Study I) or perceived pain during tests (Study II) were in fact discharged prematurely from military service, receiver-operating characteristic (ROC) curves were constructed. Here the balance between sensitivity and specificity is examined graphically.

ROC curves were evolved from Second-world-war radar and sonar detection strategies to improve signal-to-noise ratios. If you increase the gain of a weak radio signal you “not only pick up the desired signal but also background noise”[86](p 97). As the gain increases the noise will also increase and finally it will be impossible to hear the signal. “The optimal setting will be where you detect the largest ratio of signal to noise”[86](p 97). The ROC curve represents this relationship as a diagram, in which signal or no signal (= correctly diagnosed, true positive or true negative) and least background noise (= incorrectly diagnosed, false positive or false negative) are visualised.

The present curves were created by plotting a point of each cut-off score that represented the proportion of correctly identified cases on the Y-axis, (discharged conscripts who had not managed 80 repetitions in the ranger test (Study I), and those discharged who had rated pain during the tests (Study II), respectively = true positive). The X-axis (1-specificity) represents the proportion of cases that were incorrectly identified, i.e. subjects who had rated pain or failed the test but completed their training, i.e. false positive. The area under the curve represents the ability of the test to predict, in this case, between those who will be discharged and those who will stay the course. In a perfect test, the true positive value will be 1.0 and the false positive value will be 0.0, giving a curve that fills the square. A non-informative curve occurs when true positives and false positives are equal – 0.5, a test that could not discriminate those discharged any better than random chance.

3.6 ETHICAL APPROVAL

All the participants gave their informed consent. The Ethics Committees in Örebro, Stockholm, and Gothenburg approved the studies presented in this thesis.

Table 6. Statistical methods used in this thesis.

	Study				
Methods	**I**	**II**	**III**	**IV**	**Thesis**
Descriptive statistics					
Mean (SD)	•	•	•	•	
Median (range)	•				
Median (25^{th}, 75^{th} percentiles)	•	•			
Reproducibility or reliability					
Percent agreement			•		
Weighted Kappa		•	•		
Intraclass correlation coefficient ($ICC_{2.1}$)			•		•
Standard error of measurement (SEM, SEM%)			•		•
Differences					
Same-subject					
Friedman two-way analysis		•			
Wilcoxon signed-ranks test		•			
Bonferroni correction		•			
Different subject					
Chi-square test	•	•	•	•	
Mann-Whitney *U* test		•	•	•	
Student's *t* test (unrelated)	•		•	•	
Association					
Correlation					
Pearson product-moment correlation coefficient	•				
Spearman correlation coefficient			•	•	
Regression					
Logistic regression			•	•	
Univariate analysis			•	•	
Risk Ratio	•				
Sensitivity specificity					
ROC curves	•	•			

4 RESULTS

4.1 THE RANGER TEST

The ranger test had high discriminating ability and predictive value for premature discharge caused by knee or back problems during strenuous military ranger training (Study I).

Significant differences in test performance at the start of the training were found between conscripts who were discharged and those who completed the training ($p<0.001$). The risk ratio for discharge for whatever reason was 4.1 (2.5-6.7, 95% CI) for those who fell below the cut-off level of 80 repetitions.

The ROC curves illustrate the sensitivity and specificity of failing the test in relation to being discharged from training, Figure 5. The area under the curve (Study I) was 0.91 (SE 0.09) for discharge attributable to knee problems. The area under the curve for discharge due to knee and back problems was 0.80 (SE 0.08). The specificity of the test increased when the pass number of test repetitions was lowered. An optimal cut-off point (the abrupt change in the curve direction) for discharge due to knee problems was 50 repetitions (sensitivity 0.83 and specificity 0.98). The optimal cut-off point for discharge due to knee and back problems was 70 repetitions (sensitivity 0.64 and specificity 0.95).

The pass rate in the submaximal test was set to 80 repetitions with each leg. This was based on the results from the maximal performance test, (median number 219, (range, 65-761), only one conscript falling below 80 repetitions.

Unpublished data from Study IV showed that fewer ranger conscripts were discharged among those who had passed the ranger test during enrolment ($p=0.024$).

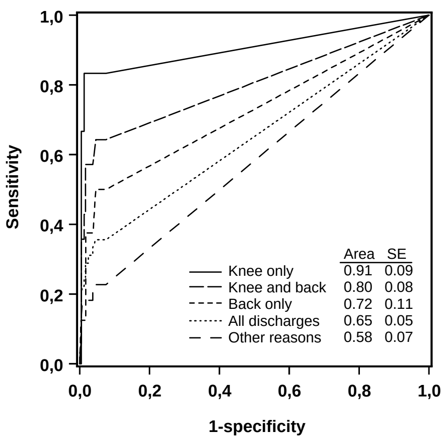

Figure 5. Receiver-operating characteristic curves showing relationship between sensitivity and 1-specificity of results of the ranger test at different failure points for subjects failing the test on one or both legs. Five curves are presented, indicating knee problems, knee- and back problems, back problems, all discharges, and other reasons for discharge. (Larsson et al, 2006, Military Medicine: International Journal of AMSUS) [77].

4.2 THE LOWER-LIMB-LOADING TEST WITH PAIN-INTENSITY RATINGS

The set of four lower-limb-loading tests was a reliable and valid tool in detecting knee pain in conscripts during military service (Study II).

There was a significant difference in pain intensity ratings between the different tests ($p<0.001$). The rising and step-down tests were more provocative and identified more conscripts with pain than the step-up and squat tests did, Figure 6. Significantly, more conscripts were identified with the tests than with the questionnaire ($p<0.001$).

The reproducibility of the pain-intensity ratings showed excellent agreement. Weighted κ values ranged between 0.84 and 0.97 except for the bilateral squat test in the left leg, which was 0.79.

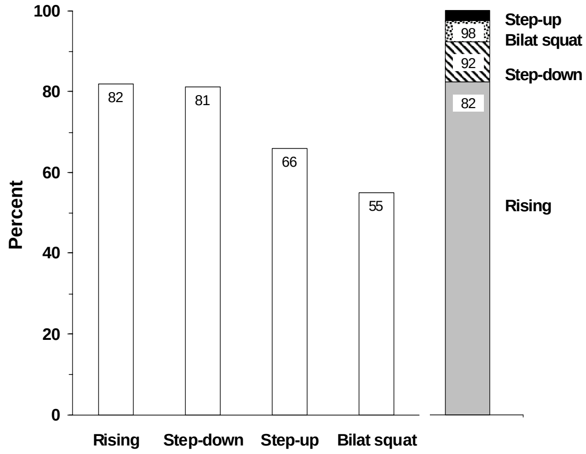

Figure 6. Percentages of conscripts rating pain in the left, right or both knees, with ratings of pain intensity (>0) on the Borg CR10 scale from tests administered at the start of training in the artillery unit. The bar on the right indicates the percentages of subjects identified, when one, two, three or four tests were included in a test tool. (Larsson et al, 2008, Military Medicine: International Journal of AMSUS) [89].

4.3 RISK FACTORS

Musculoskeletal complaints or injuries current at the start of the training (Studies II, III, IV), especially in the knee (Studies II, IV) being physically inactive (Study III), high physical load (Study IV), perceived poor mental health (Study III,) being mentally unprepared (Study IV) or smoking cigarettes (Study III) were factors independently and significantly associated with premature discharge.

4.3.1 Musculoskeletal complaints or injuries (MSCI)

Background data revealed that 41% of conscripts (Study III), and 35% in intervention group A (as planned) and 33% in group B (less intensive) in Study IV, reported current complaints or injuries in any part of the body when starting their military service. The major locations were the lower back and the knee.

Table 7. Point prevalence of musculoskeletal complaints or injuries in one army unit, n=469. Those who completed the training, n=403, compared with those who were discharged, n=66 and unadjusted odds ratios (Crude OR) with associated 95% confidence interval (95%CI) in relation to discharge, (study III).

	Point prevalence				**Crude OR (95%CI)**
		Discharged			
	Total	**No**	**Yes**		
n	469	403	66		
	%	%	%	p-value	
No complaints or injuries					*1.0*
Complaints or injuries					
Neck	6	5	15	0.005	3.4 (1.5-7.7)
Upper back	5	5	11	0.058	ns
Lower back	17	14	36	<0.001	3.5 (2.0-6.2)
Shoulder	7	6	12	0.064	ns
Elbow	1	1	0	0.544	ns
Hand	4	3	8	0.093	ns
Hip	3	3	3	0.567	ns
Knee	16	13	33	<0.001	3.4 (1.9-6.1)
Calf	3	3	5	0.355	ns
Foot	9	8	17	0.026	2.3 (1.1-4.9)
Any part	41	35	76	<0.001	5.9 (3.2-10.7)
Multiple	19	16	36	<0.001	2.9 (1.7-5.1)

ns–non significant

Significantly more conscripts who were prematurely discharged (Study III) had reported complaints or injuries *in any part of the body* at the start of training than did those who completed the training ($p<0.001$). The one-year prevalence the year before starting military service and the point prevalence for lower-back and knee complaints or injuries were significantly higher ($p<0.001$) for those discharged than for those who completed training. Table 7 illustrates the point prevalence of MSCI in different anatomical locations among those who completed the training compared with those who were discharged (Study III). The unadjusted odds ratios (crude OR) with associated confidence interval (95%) for discharge are also presented in Table 7.

With no intervention (Study III) the crude OR for discharge was significant for neck, lower back, knee, foot, any location and multiple locations. The point prevalence (Study IV) of reported musculoskeletal complaints or injuries and the unadjusted odds ratios for discharge from the two intervention groups are given in Table 4 in Study IV. In group A, intervention programme as planned, the crude odds ratios in relation to discharge were non-significant. In group B however, the crude odds ratios for discharge were significant for lower back, hand, knee, any location and multiple locations. Discharged conscripts with current MSCI at service start rated significantly higher perceived pain intensity on VAS than non-discharged conscripts did (median 56 vs. 36mm, $p<0.001$) (Study IV).

Table 8. Unadjusted odds ratios (Crude OR) and adjusted odds ratios (OR) with associated 95% confidence interval (95%CI) in the explanatory variables included in the logistic regression analysis, n=459 (study III).

Variable	**Crude** OR (95 % CI)	**Adjusted** OR (95 % CI)
Complaints at present [a]		
no	*1.0*	*1.0*
yes	5.9 (3.2-10.7)	4.6 (2.4-8.7)
Knee pain during lower-limb tests		
no pain	*1.0*	*1.0*
pain of >0 to $\leq$1	2.8 (1.2-6.4)	ns
pain of >1	2.3 (1.2-4.2)	ns
Physically		
highly active	*1.0*	*1.0*
active	ns	ns
inactive	2.5 (1.4-4.7)	2.0 (1.0-4.0)
BMI		
19.0-24.9	*1.0*	*1.0*
<19	ns	ns
25-29.9	ns	ns
>30	2.2 (1.0-4.8)	ns
Smoking		
no	*1.0*	*1.0*
yes	3.2 (1.8-5.8)	2.7 (1.4-5.5)
Physically unprepared		
no	*1.0*	*1.0*
yes	2.1 (1.2-3.5)	ns
Mentally unprepared		
no	*1.0*	*1.0*
yes	2.6 (1.5-4.4)	ns
Self-rated physical health		
excellent	*1.0*	*1.0*
good	ns	ns
poor	5.5 (2.4-12.6)	ns
Self-rated mental health		
excellent	*1.0*	*1.0*
good	ns	ns
poor	5.8 (2.9-11.5)	3.6 (1.6-7.8)
Self-rated physical environment		
excellent	*1.0*	*1.0*
good	ns	ns
poor	2.9 (1.3-6.4)	ns
Self-rated working capacity		
excellent	*1.0*	*1.0*
good	ns	ns
poor	5.0 (2.3-11.0)	ns
Nagelkerke R square		0.28
Correctly predicted %		87.1

[a] In any anatomical location, ns–non significant.

Prevalence of MSCI (current complaints or injuries) in any of the anatomical locations was one of the variables included in the multiple logistic regression analyses. The adjusted OR for discharge was 4.6 (2.4-8.7 95%CI) (Study III, Table 8). The adjusted OR was 2.3 (1.3-3.9 95%CI) for group B in Study IV. However, the crude OR was non-significant for group A, so the variable was not examined in the final logistic regression model, (see Table 6 in Study IV).

More ranger conscripts among the discharged group rated *pain during the lower-limb-loading tests* than among those who completed the training ($p<0.001$), indicating a predictive validity of the screening test for premature discharge (Study II). Twelve ranger conscripts were classified as outliers or extremes in the ratings of pain in the left or right leg. All except one were discharged. Four of these had not taken the ranger test at enlistment.

The ROC curves illustrate the sensitivity and specificity of the pain-intensity ratings in relation to being discharged from training due to knee problems, Figure 7. With a cut-off score (the abrupt change in the curve direction) of 0.4 on CR10 (i.e. extremely weak pain) the sensitivity was 0.86 and the specificity 0.92 (80% of ranger conscripts who did not complete their service were identified). The corresponding figures, using the same cut-off, 0.4, for the rising test were 0.71 and 0.89, for the step test 0.57 and 0.93 and for the squat 0.57 and 0.89.

Significantly more artillery conscripts in the discharge groups rated perceived pain during the *lower-limb-loading tests* in Study III ($p=0.003$). This difference was not found in intervention programme B (Study IV). However, perceived pain during tests was a predictive factor for conscripts in group A, with an adjusted OR of 8.0 (1.9-33.1 95%CI) for those who rated perceived intensity of pain >1 on the Borg CR10 scale.

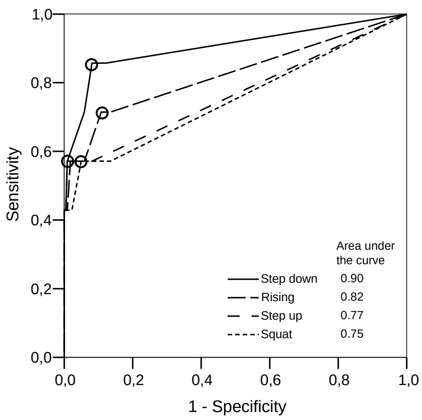

Figure 7. Pain intensity ratings and discharge from military training. The predictive values of the four tests indicated by the ROC curves are illustrated as relationships between sensitivity and 1-specificity at different levels, for conscripts reporting pain (>0 on the Borg CR10 scale) during each of the four lower-limb tests, and discharge from military training caused by knee problems. The score represents 0.4 on Borg CR10. (Larsson et al 2008, Military Medicine: International Journal of AMSUS) [89].

4.3.2 Physical factors

Leisure-time inactivity before military service was independently and significantly associated with discharge in Study III, adjusted OR 2.0 (1.0-4.0 95%CI). This potential predictor did not remain in the final multiple regression in Study IV. However, the crude OR was 1.8 (1.0-3.1 95%CI) in group B, but no association for discharge was found for conscripts in group A. Conscripts who reported feeling physically unprepared for military service (Study III) ran an increased risk of discharge, crude OR 2.1 (1.2-3.5 95%CI). For conscripts in group B in Study IV the crude OR was 2.7 (1.7-4.3 95%CI).

No significant range-of-motion (ROM) differences were established between those who were discharged and those who completed training (Studies III, IV). However, another finding in both Study III and Study IV was an association between decreased knee-extensor flexibility and current knee complaints or injuries (p=0.005 in Study III, and p=0.003, Study IV).

There was no significant difference in muscular performance (Isokai) between those who were discharged and those who completed training, as tested on enrolment (*N*) or in the muscular performance test at call-up (Study III).

Muscle performance was evaluated in four muscle endurance tests in Study IV. Low test performance in push-ups, sit-ups or chins did not associate with premature discharge. However, conscripts with current complaints or injuries in the lower back achieved significantly lower times during the static back endurance test than those without complaints or injuries did (p=0.018). The crude odds ratio for discharge in the whole study population was 1.8 (1.1-3.0 95%CI).

The test-retest reproducibility of the muscle endurance tests was investigated in 31 conscripts and is presented in Table 9. Test results increased from test 1 to test 2 in push-up and chins. The variance was not related to the mean. The $ICC_{2.1}$ ranged between 0.89 and 0.95 indicating excellent reproducibility for back extension and push-ups and good reproducibility for sit-ups and chins.

Table 9. Mean and standard deviation (SD), Intraclass correlation coefficient (ICC), standard error measurement (SEM), SEM% and smallest real difference (SRD) from muscle endurance test-retests.

		Test I	**Test 2**	**$ICC_{2.1}$**	**SEM**	**SEM%**	**SRD**
Test	n	Mean (SD)	Mean (SD)				
Back extension (s)	29	132 (32)	131 (31)	0.95	7	6	20
Push-ups (reps)	30	39 (9)	41 (10)	0.93	3	7	7
Sit-ups (reps)	31	35 (13)	36 (15)	0.89	5	13	13
Chins (reps)	31	9 (3)	10 (3)	0.89	1	10	3

4.3.3 Mental, emotional and social factors

Prematurely discharged conscripts rated their experience of mental health significantly lower ($p<0.001$) than those who completed training (Study III). The adjusted OR for discharge was 3.6 (1.6-7.8 95%CI), Table 8. In the logistic regression models in Study IV, this potential predictor of premature discharge was removed in the backward elimination. However, being mentally unprepared (Study IV) emerged in group B as a predictive factor for discharge, adjusted OR 3.5 (1.6-7.8 95%CI). In the same group, the crude OR for the factor being unmotivated for military service was 7.6 (4.6-12.4 95%CI); but this was not statistically significant in the logistic regression, adjusted OR 2.2 (0.99-4.72 95%CI), (see Table 6 in Study IV).

4.3.4 Personal factors

Smoking was significantly more frequent in the prematurely discharged group (Study III) 32% vs. 13%, ($p<0.001$) and here the adjusted OR for premature discharge was 2.7 (1.4-5.5 95%CI). Body mass index, BMI (Study III) was significantly higher in discharged conscripts, 25 kg/m^2 compared to those who completed training, 23 kg/m^2 ($p=0.030$). The adjusted OR for premature discharge was not statistically significant.

4.3.5 Extrinsic factors

The exposure factor high workload during the first tree months of service emerged in group B as predictive of discharge, adjusted OR 2.6 (1.5-4.5 95%CI).

4.4 COMPREHENSIVE INTERVENTION

The discharge rate was lower in all three units after the intervention programmes than in the previous year: artillery ($p=0.003$) ranger ($p=0.004$) and engineer ($p=0.033$). Comparing the two intervention programmes, significantly fewer conscripts (6.1%) were discharged in group A (intervention as planned) than in group B (less intensive intervention) (13.1%) ($p=0.002$). Both programmes were applied in the ranger unit, with significantly fewer discharged conscripts in group A ($p=0.001$). The logistic regression analysis with *all* subjects (n=862) revealed that the intervention as planned (group A) decreased the odds of discharge significantly, OR 0.5 (0.3-0.9 95%CI).

Both intervention programmes were applied in the ranger unit, with significantly fewer discharged conscripts in Group A, ($p=0.009$). The premature discharge rate was 7.9% for ranger conscripts who participated 'as planned' compared to the 'less intensive intervention' group, 16.5% (in Table 3, in Study IV).

No difference between group A and group B was found in the distribution of reasons for premature discharge. The registered reasons were musculoskeletal (36%, 37%), psychosocial (43%, 45%) medical (7%, 6%), other not specified (7%, 2%) and conscientious objectors assigned to civilian activity (7%, 10%).

5 GENERAL DISCUSSION

The overall aim of the work described in this thesis was to identify risk factors and to describe and analyse the influence of preventive intervention on premature discharge from military service. The findings showed that several risk factors for premature discharge could be identified at the time the service began. Musculoskeletal complaints and injuries current at training start were identified as risk factors for premature discharge. A supplementary selection procedure during enrolment for ranger conscripts was important for those required to carry heavy loads. Fewer prematurely discharged conscripts in comparison with historical data indicates that the newly-developed intervention programme implemented in three army units was effective. However, the results can be generalised only to male conscripts, as females were not included in the analyses.

5.1 FINDINGS

The comprehensive intervention comprised cohorts from three different army units, ranger, artillery and engineer, whose members have different tasks with varying physical demands. The result demonstrated a reduced discharge rate in all three units during the comprehensive intervention compared to historical data. Unforeseen circumstances meant that not all the conscripts underwent the intervention 'as planned'. This was not originally part of the study design, but led to possibilities to compare effects of different administrations between two comparable groups. *The proportion was less than half as high among those in the intervention-performed-'as-planned' group*, indicating that a more intensive programme was needed. The ranger unit, the most physically demanding unit with greater demands on the musculoskeletal system, was represented in both groups.

The musculoskeletal screening protocol (MSP) was constructed to identify individuals needing early rehabilitation or individual physical training/ exercise programmes. Treatment and rehabilitation were important. However, a treatment strategy without reducing the gap between individual functional capacities and environmental demands seems insufficient (unpublished data from one army unit during the development of the MSP). This is consistent with previously-reported investigations [52;53;56]. Training of all officers, another important task in the intervention, would probably not work by itself, either [58]. The findings from the present investigation demonstrate the benefits of a more 'offensive' comprehensive intervention. A rehabilitation and preventive programme integrated in daily work with the officers/ instructors and physiotherapist co-operating as in Group A 'intervention as planned' had a significantly greater effect on discharge outcomes than a less offensive programme did. Thus was taken the first step in implementing a process - the ability process – that included treatment, rehabilitation, primary preventive and promotion strategies.

Musculoskeletal complaints or injuries (MSCI) present at service start emerged as a strong predictor of discharge (Studies II, III, and IV (group B). A remarkably high prevalence of MSCI was identified in this population. The result tallies with research on civilian groups [90;91]. However, fewer than half of those enrolled during one year, n= 46 966, have qualifications for military service [6] and statistics demonstrate that 19 279 young men are disqualified from enlistment for health reasons. The high prevalence of MSCI in the present investigations could be explained by the fact that MSCI included symptoms beyond the disease criteria, i.e. musculoskeletal complaints, and did not necessarily have support in a strictly *biomedically-based diagnosis*.

In ‘the ability process’, disorder as well as functional limitations without disorder were identified. This differs from the ‘disablement model’ where the pathology comes first [2;64;86;92]. With the proposed screening, proper treatment and rehabilitation including adjusted physical training and loading was started immediately (in group A) so as to prevent exacerbation of pre-existing conditions. This was the alternative to waiting for problems to arise only when the conscript did not manage his duties, i.e. suffered participation restriction.

That low performance of the ranger test disqualified conscripts from the physically demanding ranger unit (Study I), was confirmed in Study IV. There were fewer discharged conscripts among those who had passed the test at enrolment. These rangers were enlisted five years after the test became part of the enrolment procedure. They should have taken the ranger test during enrolment but for different reasons some did not do so.

Despite this extra test for selection to ranger units, a high overall rate of prematurely discharged conscripts (20-27 %) was reported in earlier years. High physical demands, especially at the beginning of the service could be one reason [32;34]. The year before the intervention study the load carried by ranger conscripts after two weeks’ service was 61-89 % of body weight, a considerable proportion of an individual’s body mass, Figure 2. There are no official policies regarding restriction of total loads during marches for Swedish conscripts. However, the Swedish Work Environment Authority recommend a limit of 25 kg when manually handling materiel [93]. One important question was -When do we reach an injurious level, if we have not already done so? After years in school [19] the ability to sustain all physical activities during military service, including weight-bearing exercise, is limited [23]. Well-motivated subjects run a conscious risk of being injured due to overloading exercises.

For the ranger conscripts, it was important to reduce the initial load [28]. During the intervention, we did not manage to decrease the load carried to half that of the previous year in either group: it remained high at 40 kg. However, a physically strenuous trade was associated with discharge in group B, but not in group A, Study IV. The findings indicate that exercise and loading were better adjusted when the instructors were aware of their conscripts’ capacities (group-A). Injury risk and high physical load have been discussed earlier [23;32]. For a physically inactive and untrained person even relatively low exposure could result in an overuse situation [42;43].

In Study III we found that the risk of premature discharge was greater for those who had been physically inactive the year before military service. Preparation before military service is important [50], and preconditioning of low-fit soldiers reduced attrition in a study by Knapik et al [1]. Davidson et al [94] found that lower-limb injury rates were more than five times greater for recruits during military training in New Zealand than for trained personnel. The British Army has lately implemented a three-week aerobic training programme, but the effect of the intervention has not yet been assessed [15]. In the U.S. Army soldiers may be ‘preconditioned’ in special Fitness Assessment Programs [57]. While the Swedish Armed Forces lack this possibility, attempts can be made for people enrolled for military service to start their physical preparation before call-up.

Another finding from a pilot study (unpublished data) and from Study III was that conscripts were dissatisfied with irregular physical exercise and training during service (unpublished data). Therefore, one important part in the intervention, Study IV (group-A), was a physical exercise and training programme run twice a week, plus appropriate programmes for every-morning exercise. Principles for trunk stabilisation targeting deep neck, abdomen and back muscles were also included [95]. The challenge is to balance and optimise the training with other physical activities, particularly weight-bearing, especially for inactive and unprepared conscripts [23]. In two studies by Knapik et al [57;58] physical readiness training during military training reduced overuse injuries. Williams and Rayson [96] suggest that the training should be based on actual task performance. There is support in the literature from civilian populations that physical exercise has positive effects on health when matched to work demands [97].

Overweight (BMI>30) [72] was associated with premature discharge in Study III. The association with discharge and BMI<18 or >25 has been discussed earlier [13] as have those with injury and BMI >25 [20;33], and BMI >30 [48]. Blacker et al [15], however, found a lower risk of injury for those with BMI 23-28. Larger recruits could better cope with load-carrying, and the authors suggest that this may be modified through adjustments to selection and training. Body size and selection to different posts in military service must be considered. For an individual with a low body mass, the total load (personal equipment) can constitute an excessive load level [96;98-100]. Load-carrying tests have been suggested as an occupational fitness measure when predicting the conscript's ability to work with such tasks [96;98;100;101]. It is evident that body size influences tests results in assessment of physical fitness. Smaller and lighter personnel have an advantage compared to larger in tests when the primary resistance is body weight [96;98-100;102]. For selection to different posts, the most common military physical fitness tests (i.e. sit-ups, push-ups, and shuttle runs [1] might therefore be inappropriate, since most military tasks require individuals to move not only themselves but also equipment. Personnel with larger lean-body mass have a relative advantage in load-carrying [98-100].

The present muscle endurance tests were performed to identify those who needed an exercise programme i.e. primary prevention, not selection. An indication that low performance on back-muscle extensors could be a risk of premature discharge was found in the whole group, crude OR 1.8. Recent studies have found low performance in the APFT test, i.e. sit-ups and push-ups, associated with discharge [7;11]. We found no such correlation. There might be several reasons for the conflicting results. The intervention itself could be a confounder and bias the results; or that our conscripts had already passed physical tests during enrolment.

The major locations of complaints or injuries were lower back and knees (Studies III, IV). Low performance in the back-extension test (Study IV) was associated with back pain. Earlier studies have found that low-back pain decrease performance time [83;103-105]. The present screening test was to identify subjects who needed intervention due to low performance. Another finding (Studies III and IV) was an association between decreased knee flexibility and unspecified knee pain. This might be important to observe, as a stretching regimen might improve the ability to work in different strained postures, such as shooting when kneeling. This is however debated. Authors who support stretching programmes [63;82;106;107] disagree with those who do not [108-112].

Lincoln et al [32] found that chronic knee conditions were more likely to result in disability than acute knee injury, confirming that both rehabilitation and preventive strategies are important.

Self-rated poor mental health and mental unpreparedness for military service are important to observe. Findings from Study III and group B (Study IV) demonstrate, as previously discussed, that mental health should be more fully addressed, and that negative effects are preventable [8;12;55;56]. A mental-health intervention successfully reduced the discharge rate in Navy recruits [55]. The comparison with this study might be biased as there are different physical and psychological demands and stressors on Navy conscripts compared to Army [94]. However, these factors did not associate with premature discharge for our conscripts in group A, intervention as planned. It is reasonable that poor motivation and poor perceived mental health may be better tackled when problems are taken seriously and each individual's needs are noted at an early stage. This agrees with a study by Dorotka et al [21] who found that soldiers who feel that the regular military personnel do not understand them exhibit more symptoms than those who do not so feel.

A survey such as the present MSP may be of use in a different perspective than that outlined above. Officers have expressed the opinion that the unit must not be some kind of rehabilitation institute. The objection is relevant: the training period is short and if it includes individuals with major needs for rehabilitation, this may have an unfavourable effect on the regular work. In some cases it is necessary for conscripts to terminate their training. Through systematic surveying in connection with call-up and proper clinical investigation, individuals incapable of completing their training may be identified [9]. In this way, the time taken to decide about altered enrolment posting or possible termination can be shortened using the intervention resources.

Uncertainties regarding the requirements for different tasks in the Swedish Armed Forces – as in other armed forces [34] – constitute a major problem of selection. Physical and psychological demands during military service differ between units and posts /tasks [20;32] which implies that an individual's limitation in one context does not necessary exclude him from another. Therefore, as witness de Raad et al [113], an analysis of all military tasks in the Swedish Armed Forces according to their specific physical and psychological requirements – a "job analysis" is needed. Concerning this, various factors have been systematically mapped but not analysed so far. The present work may form a basis for future analysis of physical capacity.

The three-dimensional theoretical model, the cube in Figure 4, describes the measurements included in the present work. From a selection point of view it would be optimal if all assessments and tests were evaluated at 'participation' level, especially 'combat performance'. However, a selection procedure should also be supplemented with a systematic survey to enable adjustment of the gap between military tasks and conscripts capabilities [65] thus preventing premature discharges.

5.2 METHODOLOGICAL CONSIDERATIONS AND LIMITATIONS

5.2.1 Subjects and outcome

The present subjects were members of conscript cohorts selected from different military units. Only 2.3% of those who were recruited were excluded from the study or dropped out during the period. Hence selection bias is limited.

The outcome was premature discharge from military service. Those discharged due to impaired hearing were excluded from the predictive analysis, as they were not allowed to stay on the course even if they wanted to. No intervention strategy could change this reality. One problem in the classification of premature discharge [30;31;36] is that the official reason may differ from the real one [14]. Thus, overall premature discharge was the dependent variable in the predictive analysis. However, in Study I separate analyses were run for discharge due to knee and back trouble resulting in wide but significant confidence intervals due to low outcome rates.

One may ask whether these results are valid for women as for example their mean body weight and height are less than those of men. The author is currently (May 2009) studying this.

5.2.2 The ranger test

During the development of the ranger test, a lower-limb functional capacity test to supplement enrolment tests of applicants to physically demanding ranger units, there were several factors to consider.

To forecast whether applicants would be able to manage strenuous military training or will risk developing knee problems a strenuous test was relevant [101;114]. *The test load, including the number of repetitions,* was a factor that had to be investigated to determine the height of the bench and weight of the backpack. No such test found was in the literature, which made it impossible to compare ours with an already-established one [86]. According to Carmines and Zeller [115] criterion-related validity can, however, be tested as predictive validity. A future outcome may be predicted [86], in this case, completion of or premature discharge from basic training. To minimise the injury risk during a maximal test with high exposure, we limited the relevant study group to one platoon with 38 conscripts. This was considered sufficient for determining the capacity of the present ranger conscripts.

The biomechanics differed according to the height of the rise. Our bench was 0.4-m high, which meant that the individual torque and the joint angles needed for performance were influenced by the subjects' height. The correlation between body height and test result was r= 0.47. As load carrying in terrain for a shorter person differs from similar work for a taller person, the same height of the bench was used during testing, not taking subject height into account [116].

Load-carrying while mounting stairs has earlier been suggested as a more sensitive functional test when evaluating the capacity for job that places heavy demands on the knee compared to unloaded stair mounting [117]. The present backpack weighed 20 kg. However, if the initial weight the ranger soldier has to carry exceeds 40 kg it could be questioned whether a load of 20 kg during a selection test is sufficient. For safety reasons, the load during the testing must be considered in relation to the risk of injury. It is also reasonable to believe that if conscripts could sustain a higher load level during the test, the load carried during the training will increase [28]. The test was evaluated according to its sensitivity and specificity for premature discharge. From an injury-preventive point of view, failing to predict that an applicant will be able to manage the ranger service (false positive) seems less serious than not predicting a success that does not occur (false negative). This implies that those who were false-positive on the test will be excluded from military service. Applicants who had been enlisted but lacked the capacity for ranger service, i.e. were false-negative on the test, might run an increased risk of injury if the physical demands are greater than their capacity. The cut-off values are therefore important.

5.2.3 Musculoskeletal screening protocol

When the study started, no current instrument was found based on the disablement theory [2] and suitable for use in a population with high functional ability. The most relevant limitation was the ceiling effect, as available instruments were not constructed to measure the high functional ability seen in a physically active clientele[65] such as the military.

Reliability, necessary but insufficient for validity [69], sets the limits of validity but does not guarantee it [86]. If reliability is an empirical issue, validity is usually more theoretically oriented, raising the question “valid for what purpose?” [86;115]. Test-retest reliability of the questionnaire and the pain intensity ratings was in general good-to-excellent. The five questions on self-rated health had less test-retest reliability, which might be due to the number of steps in the scale or to what had happened during the time between test and retest. The questions were designed to assess ‘daytime’ status[73]. However, in the present study the number of steps was reduced to three categories. We used the questions for discriminating and predicting: for evaluating effect size, the questions need further investigation.

It was important that our measurements were experienced as meaningful to the individual tested [67], i.e. had high face validity [86] as all the tests were intended to make the individual himself, his instructors and other medical personnel, aware of the situation. Content validity indicates how well the contents of an instrument represent aspects of the topic being studied and how far the domain of interest is comprehensively sampled by the items or questions in the instrument [67;86]. Our investigation of content validity covered several years during which the predictive validity of the test battery was investigated in two different army units not presented here (unpublished data). Tests were applied at the start and at the end of service. The results from the two units were used when interpreting test results and to establish what was relevant and how to work in ‘the ability process’.

The MSP was used to identify those with current musculoskeletal complaints or injuries and early signs of functional limitation. Information bias, (i.e. misclassification) could affect the result. Most data were based on self-reports: here an overestimation of the complaints could result in a high prevalence. However, with a non-differential misclassification of exposure, e.g. a questionnaire that does not give enough information, the bias could result in underestimating the strength of an association. Any effect of an exposure measured with a dichotomous variable will bias toward the null value [118]. The prevalence of MSCI has been fairly constant during recent years (2001-2004) 33.4-40%. The present MSP was designed for screening purposes, and was found valid and reliable for discriminating male conscripts in army units against comprehensive interventions.

The lower-limb-loading tests with rating of pain-intensity discriminated subjects with knee pain and predicted premature discharge from ranger units, as indicated by the ROC curves. The tests supplemented the questionnaire.

One limitation is the dropouts, 6% in the muscle endurance tests. This could bias the predictive value of the result and needs to be further addressed. Some variables have missing data below one percent. To check that missing data did not bias the result, data were imputed with means or median values. Regressions were then applied with and without imputation. As imputation did not change the results for any of these variables compared to non-imputation, data without imputation are presented. Another limitation was that aerobic capacity was based on self reports.

The ICC values of the Isokai and muscle endurance tests indicated good reliability [86].

5.2.4 The comprehensive intervention programme

Resources in time and personnel must be considered when a new intervention programme is to be introduced [53]. In the proposed 'ability process' conscripts who are tested positive will be examined during the first few weeks. Those tested 'false-positive' will take resources and generate costs unnecessarily, but in the ability process they will be identified at an early stage.

The effect of the intervention (Study IV) regarding reduced premature discharge should be evaluated against the cost of this possible extra work. For units that already employ physiotherapists / ergonomists, the ability process involves no increase in personnel costs, simply a different way of working. Since conscripts requiring treatment need not be referred via a nurse and physician, the total time for the measure is reduced and hence the unit's personnel resources are used more efficiently. If this procedure can also lead to reduced incidence of injury during training, the savings become even greater. This should be further studied.

Other baseline factors may not have been controlled for. The many components of the intervention programme, study IV, rendered it impossible to determine the effectiveness of one factor alone, and the same variable could, in different contexts, have been a confounder, a moderator or a mediator [119]. Further examination of how these factors relate to the data investigated may allow a more accurate interpretation of the causal effects of an intervention [119].

5.3 IMPLICATIONS AND IMPLEMENTATION

The design of study IV limits the scope of conclusions about the effect of the programme. However, statistics from the comprehensive intervention continued 'as planned' in the whole ranger unit the year after the study confirm the present results, i.e. a continued low discharge rate, 7.5 % (unpublished data). Statistics from the other units are consistent with these. No rehabilitation was available for conscripts in the *artillery unit* investigated in Study III, where 14.9 % were prematurely discharged *(in 2002).* This may be compared with the same artillery unit in Study IV when the intervention was as planned for the next year's intake, January 2003 and the discharge rate was 5.8 %. For those who started the training late in 2003 (same unit) no intervention programme was applied, and the discharge rate was similar to the previous year, 15.1 %. Women were not included in the analyses of the program. However, they participated in the comprehensive intervention. None of the nine women was prematurely discharged during the study year supporting that the program can be implemented for both men and women. With the present study design it is not possible to conclude which of the components was the most important, or that the subjects felt that their problems were taken seriously, or a combination thereof.

During the present work the tests have been implemented in the Swedish Armed Forces; the ranger test in connection with enrolment for selection to physically demanding trades (ranger units), and the lower-limb-loading test (the one-leg-rising test) for identifying possible knee disorders before the ranger test.

All the tests presented in this thesis can serve for mass testing in intervention programmes with minimal equipment purchase or apparatus development.

The comprehensive intervention programme was implemented in the two study units and for officer cadets during their training. There are plans to implement the programme throughout the Swedish Armed Forces.

The present work has also prompted a special training programme for starting preventive work earlier. Here, all those who are to perform military service receive a training programme, 'TRÄNA', during enrolment and are urged to prepare themselves physically for call-up.

5.4 FUTURE RESEARCH

Problem areas in load ergonomics noted in the present work include the carrying of packs. This broad area is important for the Armed Forces, which as employers are responsible for many people undergoing training and participating in missions. Further analysis of risk factors is a central issue for systematic Armed Forces activity regarding the work environment.

Based on the present findings there is a need

- to investigate the incidence of disorders and injuries,
- to survey the ergonomic risks in differing trades including also females: to measure the magnitudes of loads, load increases, and how the individual is affected by loads,
- to further investigate the effects of different interventions and to study their cost-effectiveness, and
- to identify selection criteria for other trades than ranger service; to verify physical load levels for different trades, and to analyse whether body measurements should be a factor linked to trade / task.

6 CONCLUSION

It is concluded that different risk factors for premature discharge from military service can be identified at the time the service begins. Musculoskeletal complaints and injuries are common and constitute one important predictor of discharge. Being physically inactive, exposed to high physical load during the first three months of service, experiencing poor mental health, being mentally unprepared or smoking cigarettes are also predictors of premature discharge, and this highlights the need for improved pre-enlistment examination and early preventive strategies.

The lower-limb functional capacity test, the ranger test, has a high predictive value for discharge from ranger units caused by knee problems. Thus, the test can be used at enrolment as a supplement in the selection of applicants for ranger service, and a minimal acceptable performance standard is suggested. The supplementary selection procedure during enrolment for ranger conscripts is important for conscripts who will be required to carry heavy loads.

The set of four lower-limb-loading tests with pain-intensity ratings is a reliable and valid tool in detecting knee pain in conscripts during their military service. The set thus constitutes one tool in a systematic process for identify high-risk groups. The rising test and the step-down test identified most of the conscripts with knee pain.

The fact that fewer conscripts were prematurely discharged compared with historical data indicates that the newly-developed comprehensive intervention programme implemented in three army units is effective. However, the differing results, i.e. different predictors and numbers discharged between the intervention groups, indicate that the effectiveness is higher when the intervention is fully implemented with regard to intensity. The programme can be applied in units with physically strenuous service as well as in units with lower physical demands. The programme presupposes the availability of specially-trained physiotherapists to work with load-elicited and psychosocial factors.

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APPENDIX 1-4

1. Frågeformulär
2. Testinstruktion funktionstest
3. Borg CR 10 skala
4. Testinstruktion muskel uthållighetstester (Svensk version),
   Fotograf: Fredrik Hofgaard
   Test instruction muscle endurance tests (English version)

Appendix 1

FRÅGEFORMULÄR inför inryckning Datum……………………………

Personnummer…………………….. Namn……………………………………………

Kompani…………………………… Plut……………………………………………...

1. Vad har varit Din huvudsakliga sysselsättning före inryckning?
   ¤ Studier
   ¤ Arbete vilket?…………………………………………
   som Du upplevde var
   ¤ fysiskt lätt eller ¤ fysiskt ansträngande

2. Boende
   ¤ Landsbygd
   ¤ Småstad/samhälle
   ¤ Större stad / storstad

Fysisk aktivitet

Kryssa i hur ofta du ägnar dig åt fysisk aktivitet på hög /medelhög respektive låg ansträngningsnivå (motions-, idrotts-, eller frilufsaktiviteter).

3. Hur ofta ägnar du dig åt fysisk aktivitet på **hög/medelhög ansträngningsnivå** (du har högre puls och blir andfådd och svettig)?
   ¤ aldrig
   ¤ oregelbundet
   ¤ 1 gång/vecka
   ¤ 2 ggr/vecka
   ¤ 3 ggr/vecka eller mer

4. Hur ofta ägnar du dig åt fysisk aktivitet på **låg ansträngnings-nivå** (t ex lugna promenader och cykelturer)?
   ¤ aldrig
   ¤ oregelbundet
   ¤ 1 gång/vecka
   ¤ 2 ggr/vecka
   ¤ 3 ggr/vecka eller mer

5. Kryssa i vilka aktiviteter / idrotter som du regelbundet utövat aktivt de senaste 12 mån och försök att uppskatta antalet timmar / vecka.

¤ löpning ¤ orientering.	Antal tim / vecka?…….
¤ fotboll ¤ innebandy ¤ handboll ¤ basketboll.	Antal tim / vecka?…….
¤ längdskidor ¤ ishockey ¤ bandy.	Antal tim / vecka?…….
¤ racketsport ¤ volleyboll.	Antal tim / vecka?…….
¤ kampsport ¤ friidrott ¤ mångkamp.	Antal tim / vecka?…….
¤ styrketräning ¤ gympa/work out.	Antal tim / vecka?…….
¤ motorcross/enduro ¤ ridsport ¤ alpint.	Antal tim / vecka?…….
¤ cykel ¤ spinning.	Antal tim / vecka?…….
¤ fallskärm ¤ dykning ¤ skytte ¤ simning.	Antal tim / vecka?…….
¤ ……………….. ¤ ………………... ¤ ….…………..	Antal tim / vecka?…….

¤ Jag håller inte på med någon idrott.

Fysiska besvär / skador

6. Har du under de senaste 12 månaderna haft tillfälliga eller långvariga besvär eller skada från någon kroppsdel? Fyll i eventuell diagnos, om Du känner till den.

		Diagnos	Har Du besvär nu?
Nacke	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Bröstrygg/ mellan skulderbladen	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Ländrygg/svank	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Axlar/skuldror	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Armbåge	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Hand	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Höft/bäcken	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Knä	¤ Nej ¤ Ja	¤ Vä ¤ Hö………………… …	¤ Nej ¤ Ja ¤ Vä ¤ Hö
Underben	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja
Fot	¤ Nej ¤ Ja	……………………………… …	¤ Nej ¤ Ja

Om DU svarat nej på alla frågor i denna kolumn fortsätt till fråga 11.

7. Hur ofta har Du haft besvär?

¤ Sällan
¤ Ofta
¤ Alltid

8. Har Dina besvär påverkat Ditt dagliga liv?

¤ Inte alls
¤ Till viss del
¤ Till stor del

9. Har det hänt att Du under de senaste 12 månaderna fått stanna hemma från skolan eller varit sjukskriven från arbetet p g a Dina fysiska besvär / skador?

¤ Nej ¤ Ja

10. Har du behandlats för Dina fysiska besvär / skador?

¤ Nej

¤ Ja
¤ Med medicin
¤ Av sjukgymnast / chiropraktor
¤ Annat

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

Du som svarat att Du har aktuella besvär vid inryckning (fråga 6).

Skriv i vilken kroppsdel Du har *besvär nu* på den streckade linjen. Markera med ett kryss på linjen hur mycket besvär Du har.

……………………….

Inga besvär alls — Värsta tänkbara besvär

………………………

Inga besvär alls — Värsta tänkbara besvär

……………………………

Inga besvär alls — Värsta tänkbara besvär

…………………………..

Inga besvär alls — Värsta tänkbara besvär

Stretching

11. Hur ofta stretchar du?

¤ efter varje träningspass
¤ efter fysisk aktivitet i arbetet eller på fritid
¤ aldrig

12. Vilka muskelgrupper stretchar du?

¤ vader
¤ lårets framsida
¤ lårets baksida
¤ höftmuskler
¤ rygg
¤ nacke
¤ axlar
¤ överarmar
¤ underarmar
¤………………

13. Äter Du frukost varje dag? ¤ Nej ¤ Ja

14. Äter Du lagad mat 2 ggr/dag? ¤ Nej ¤ Ja

15. Använder Du kosttillskott? ¤ Nej ¤ Ja Om ja vilket / vilka?…………………………………………………………

16. Snusar Du? ¤ Nej ¤ Ja Antal snusprillor / dag? ……..

17. Röker Du? ¤ Nej ¤ Ja Antal cigaretter / dag? ………

18. Tycker Du att Du är tillräckligt psykiskt förberedd för att genomföra Din värnpliktstjänst? ¤ Nej ¤ Ja

19. Tycker Du att Du är tillräckligt fysiskt förberedd för att genomföra Din utbildning?

¤ Nej ¤ Ja

20. Är Du motiverad att genomföra Din värnpliktstjänst?

¤ Nej ¤ Ja

Analys av hur du ser på ansvaret för din hälsa

Det vanligaste sättet att analysera upplevelsen av den egna hälsan är att känna efter hur tillståndet i kroppen och huvudet upplevs jämfört med tidigare. För att nå lite längre i tankarna om vem som har ansvaret för din hälsa kan du ställa några frågor till dig själv. Några precisa svar om hälsa finns inte! Hälsa är som allt annat en upplevelse och upplevelser är inte exakta.
Sätt ett kryss på varje frågas linje där du tycker att det stämmer med dina tankar om hur du ser på ansvaret för din hälsa.

- Vem har ansvaret för min hälsa?

Jag________________________________**Någon annan**

Vad kan jag göra för att förbättra min hälsa?

Mycket________________________________**Inget**

- Hur mycket kan jag ha kontroll över min hälsa?

Inte alls________________________________**Mycket**

- Hur mycket påverkar mitt arbete min hälsa?

Inte alls________________________________**Mycket**

- Hur mycket påverkar min fysiska miljö min hälsa?

Inte alls________________________________**Mycket**

- Hur mycket påverkar min sociala miljö min hälsa?

Inte alls________________________________**Mycket**

Hur upplever du Din kropp?
I denna skattning ligger din samlade upplevelse av läget i din fysiska kropp, d.v.s. var du befinner dig på linjen *icke sjuk – sjuk.*

Mycket dåligt	**O**	1
Dåligt	**O**	2
	O	3
Varken bra eller dåligt	**O**	4
Bra	**O**	5
	O	6
Utmärkt, kunde inte vara bättre	**O**	7

Hur upplever du Din psykiska hälsa?
I denna skattning ligger din samlade upplevelse av läget i din psykiska kropp, d.v.s. var du befinner dig på linjen *må bra – må dåligt*.

Mycket dåligt	**O**	1
Dåligt	**O**	2
	O	3
Varken bra eller dåligt	**O**	4
Bra	**O**	5
	O	6
Utmärkt, kan inte vara bättre	**O**	**7**

Hur upplever du läget i din fysiska miljö?
I begreppet ligger din samlade upplevelse av läget i din omgivande fysiska miljö.

Mycket dåligt	**O**	1
Dåligt	**O**	2
	O	3
Varken bra eller dåligt	**O**	4
Bra	**O**	5
	O	6
Utmärkt, kan inte vara bättre	**O**	**7**

Hur upplever du läget i din sociala miljö?
I begreppet ligger din samlade upplevelse av läget i din sociala miljö.

Mycket dåligt	**O**	1
Dåligt	**O**	2
	O	3
Varken bra eller dåligt	**O**	4
Bra	**O**	5
	O	6
Utmärkt, kan inte vara bättre	**O**	**7**

Hur upplever Du Din arbetsförmåga? (Hur tror Du att Du kommer att klara vpl-tiden?)
I begreppet ligger din samlade skattning av din upplevda förmåga att klara de uppgifter du har framför dig.

Mycket dålig	**O**	1
Dåligt	**O**	2
	O	3
Varken bra eller dålig	**O**	4
Bra	**O**	5
	O	6
Utmärkt, kan inte vara bättre	**O**	**7**

Appendix 2

Funktionstest

Step up

Sätt upp vänster fot på pallen (40 cm hög). Låt vänster fot vara kvar på pallen hela tiden. Kliv upp och ner med höger fot 5 gånger.

Skatta eventuell smärta i knät (Borg CR10 skala).

Byt fot. Gör samma sak med andra benet.

Step down

Stå uppe på pallen (40 cm hög).
Ha kvar vänster fot på pallen hela tiden och kliv ner med den högra foten. Upprepa 5 gånger.

Skatta eventuell smärta i knät (Borg CR10 skala).

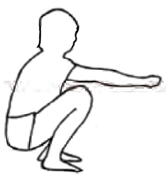
Byt fot. Gör samma sak med andra benet.

Uppresning från sittande

Sitt på pallen. Sträck höger ben och båda armarna rakt ut. Res dig upp till stående utan att ta hjälp av händerna och håll högra benet i luften. Sätt dig ner. Upprepa 5 gånger.

Skatta eventuell smärta i knät (Borg CR10 skala).

Byt fot. Gör samma sak med andra benet.



Huksittande

Sätt dig ner på huk. Du skall böja så mycket det går i knäna. Res dig upp till stående och upprepa rörelsen 5 gånger.

Skatta eventuell smärta i knät (Borg CR10 skala).

Appendix 3

Borg CR10 Skala

0	Inget alls	“Ingen P”
0.3		
0.5	Extremt svag	Just märkbar
1	Mycket svag	
1.5		
2	Svag	Lätt
2.5		
3	Måttlig	
4		
5	Stark	Tung
6		
7	Mycket stark	
8		
9		
10	**Extremt stark**	**"Max P"**
11		
•	Absolut maximum	Högsta möjliga

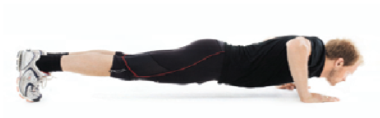
Borg CR10 skala

Appendix 4

Test instruktion

Rygg sträckning (isometrisk)
Ligg på bänken med överkroppen utanför och kroppen fixerad vid vristerna. Händerna hålls knutna vid öronen. Håll överkroppen horisontellt så länge du kan.

Push-up
Ligg på golvet, händerna placerade med axelbredds avstånd och benen med en fots avstånd mellan fötterna. Bibehåll ryggen rak under hela tiden du sträcker armarna helt och sedan sänker kroppen nästan ända ner mot golvet.



Sit-up
Ligg på rygg och placera fötterna på en pall med knän och höfter böjda i 90^{o}. Händerna hålls knutna vid öronen. Res upp överkroppen så att båda armbågarna nuddar låren och tillbaka.

Chins
Fatta stången med händerna axelbredd isär och med handflatorna mot dig. Häv dig upp så att hakan kommer över stången och långsamt tillbaka.

<u>Appendix 4 (English version)</u>

Test instruction

Back extension (isometric)
Lay prone over a bench with ankle fixation and with the upper part outside the bench with your fists placed near your ears. Keep the upper part of your body horizontal and unsupported for as long as possible.

Push-up
Put your hands on the floor shoulder-width-apart with arms flexed, the legs spread approximately one foot apart. Keep your back perfectly straight. Extend your arms and then lower yourself leaving a little space to the ground.

Sit-up
Lay on your back with the knees and hips bent 90^{o} and the feet placed on a bench. The fists placed near your ears. Lift your upper-body, elbows touch tights, and return. Keep your back rounded.

Chins
Grab the chin-bar with the hands shoulders-width-apart, palms facing towards you. Pull yourself up, cheek above the bar, and then lower yourself in a controlled fashion.

H Larsson 2009