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The Effect of Military Deployment on Mental Health

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Abstract:

In this paper we estimate the causal effect of military deployment on soldiers' mental health. To handle the selection bias problem, we use longitudinal data for deployed and non-deployed eligible men in a difference-in-differences setting. Using pair-wise matching, we impute deployment dates for the non-deployed eligible men, and our results hold to various robustness checks. Our administrative records provide objective measures of mental health service use in the form of psychiatric diagnoses and purchase of mental health-related medication. The very rich data makes it possible to control for important variables like intelligence tests and family background. We find significant adverse effects of military deployment on soldiers' mental health service use.

Highlights:

- Causal effect of military deployment on soldiers' use of mental health service
- Using a difference-in-differences approach
- First evidence relying on administrative records of measures of mental health service use
- Significant adverse effects of military deployment on soldiers' mental health service use

Keywords: Mental health, Soldiers, Deployment.

JEL Classification: I1; H56.

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1. Introduction

Over the last 20 years, with involvement in the Gulf War, operations in the Balkans, and the Global War on Terror, the number of soldiers and veterans in many countries has dramatically increased. The costs and benefits of these wars have therefore come into question in these countries. Increasing attention is now devoted to establishing the real cost of war, including the indirect cost of health outcomes for soldiers. On the one hand, military deployment may offer young people the opportunity of escaping from disadvantaged environments by providing job training and education. On the other hand, deployment experiences—in addition to the risk of injury or death—may also affect soldiers' subsequent mental health by producing psychological and behavioral dysfunction, e.g., post-traumatic stress disorder (PTSD). The direct cost of war measured in material and human life is usually huge and measured in trillions of dollars (see, e.g., Stiglitz and Bilmes, 2008). However, the indirect cost in the form of mental health and other later life outcomes for the individuals is less known. This paper both investigates and shows the causal effect of military deployment on mental health service use i.e., hospitalization and mental health medication purchase, hereafter referred to as mental health.

The military actively recruits or excludes people based on their physical and psychological characteristics. Thus investigating the relationship between active military service (i.e. deployment to war operations) and health is complicated by positive selection into the military, whereby selected individuals have to satisfy both physical and mental criteria. Differences between soldiers and non-soldiers may therefore reflect the underlying propensity (selection differences), not necessarily the causal influence, of active military service. Indeed, important differences may exist among individuals who are deployed, those who are not, and those who did not join the military. Thus the different pre-deployment selection processes may have selected certain groups of persons (see, e.g., Angrist, 1990). Furthermore, historical context, increase in manpower and economic

changes may also influence the selection criteria or the probability of volunteering, e.g., criteria may be lower during economic growth or given the need for increasing deployment participation. Therefore, we expect selection to play an important role in understanding the influence of deployment on mental health.

The literature has studied the impact of wartime conscription on a number of later life outcomes: earnings (Angrist, 1990; Grenet et al., 2011; Bauer et al., 2012), labor market attachment (Angrist, 1998), education (Angrist and Chen, 2011), and health (Angrist and Krueger, 1994; Bedard and Deschenes, 2006; Dobkin and Shabani, 2009; Angrist et al., 2010, and Autor et al., 2011).

To measure the mental health costs of military deployment, we exploit the availability of administrative records from hospitals, general practitioners (GPs), and pharmacies that in Denmark can be linked to each individual's personal registration number. Thus the very detailed Danish administrative records do not suffer from response bias or other problems related to survey data (Lyk-Jensen et al., 2012a). Moreover, in Denmark the number of soldiers deployed overseas has also risen substantially since the end of the 1990s, providing a sufficiently large sample for investigating the impact of military deployment on soldiers' mental health. Indeed, for a small country with a population of only 5.5 million, Denmark has sent 27,000 soldiers on more than 50 international military missions, resulting in more than 50,000 individual deployments over the last 20 years.

To minimize the selection bias when identifying a comparison group for the deployed soldiers, we use data for eligible men from the Danish draft board. Eligible men constitute an excellent comparison group, as both soldiers and eligible men have undergone the same selection system. We exploit the panel structure of the data in a difference-in-differences setting, thus controlling for time trends and other omitted variables affecting both the soldiers and the comparison group of eligible

men. Thus any bias caused by these variables is accounted for. Moreover, the difference-in-differences setting is also necessary for accounting for the timing. To impute a before and after period for the comparison group that corresponds to the before and after period of the deployed, we use matching. Thus within a matched pair of deployed men and non-deployed men we impute the before and after period. We match them on pre-deployment characteristics such as birth year, the result of an intelligence test ("Armed Forces Qualification Test", AFQT), and mental health (pre-psychiatric morbidity). As eligibility status also relies on physical conditions, further matching on these characteristics is unnecessary. We find a significant adverse effect of military deployment on soldiers' mental health, an effect occurring a few years after the soldiers' last mission. The effect is about one percentage point more mental health problems: An increase of 24 percent compared to the sample mean. This result holds not only for the matched sample (with random and matched dates), but also for the full sample of eligible men and one-time and many-time deployed. Furthermore, the result also holds to different choice of health measures. Our results thus contribute to a better understanding of the link between mental health problems and participation in military deployment.

Our three contributions to the literature are as follows: First, we extend previous studies by investigating the effect of deployment on mental health outcomes, making use of very high quality data. Second, this data allows identification of the effect of deployment on mental health, as we use cohorts of eligible men for military service, conditional upon them being soldiers or not, and purged of selection bias. Third, as opposed to many previous studies, our results come from military deployments to more recent wars, such as those in the Balkans, Iraq, and Afghanistan.

The paper is organized as follows. Section 2 discusses previous results from the literature and outlines our framework for testing the impact of military deployment on soldiers' mental health.

Section 3 presents the Danish military system for selecting soldiers, the dataset, and the mental health measures, based on administrative records. Section 4 discusses the empirical strategy, and section 5 presents the results and different specifications. Section 6 concludes.

2. Related work on military and health

A large body of research found that deployment to war-zone and combat in particular may have negative effects on the mental health of soldiers (e.g., Keane et al., 1989, and Dohrenwend et al., 2006). The results are PTSD and a wide range of related mental health problems that may occur co-morbidly or alone, such as depression, mania, panic disorder, alcohol and drug abuse, and conduct disorder (i.e., repetitive and persistent pattern of "antisocial behaviors.") (Schnurr et al., 2002).[4]

By contrast, deployment can also reduce the likelihood of developing depressive symptoms. Whyman et al. (2011), using National Longitudinal Survey of Youth (NLSY79), find that men who serve on active duty but do not see combat are less likely to experience depressive symptoms than their non-veteran and reserve duty counterparts—although this effect tends to dissipate after discharge from the military. Using the millennium cohort study, Wells et al. (2010) reach the same conclusion. Whyman et al. (2011) suggest several mechanisms through which active duty military service may act to reduce the likelihood of a soldier's developing depressive symptoms. These mechanisms include larger social support while serving, the development of "buddy" relationships between enlistees, and a structured environment with little crime and drug use as a possible contrast to previous and chaotic social environments. Some studies (e.g., Fontana and Rosenheck, 1998; Dohrenwend et al., 2004; Maguen et al., 2006; and Forstmeier et al., 2009) also find a positive effect of combat resulting in "post-traumatic growth", i.e. a process in which individual gain higher

[4] Although they did not necessarily participate in combat, soldiers sent to the former Yugoslavia also suffered trauma; see (Dirkzwager et al., 2005).

level of functioning than the one they had prior to the traumatic event (see Park et al., 1996; Tedeschi and Calhoun, 1996; and Linley and Joseph, 2004 for review of this concept).

Furthermore, Larson et al., (2008) report that in the U.S. Marines psychiatric disorders are diagnosed most frequently during the initial months of recruit training, rather than after combat deployment. Thus soldiers' psychological and physical robustness has been tested throughout their training, so that only those who have proven their resilience during training remain eligible for combat. This process causes a disproportionate loss of psychologically unfit personnel early in training, creating what is known as the "healthy warrior effect" (Larson et al., 2008). Consequently, a major issue in estimating the impact of deployment on soldiers' health is finding an equally healthy comparison group.

That men entering the military are not a random subset of the male population complicates any determination of the relationship between military deployment and mental health. Early studies examining the health effects of active military service compared health outcomes of those in combat with those of civilians (Jordan et al., 1991; Price et al., 2004; and Card, 1987). The problem with these studies is that the average individual and family background characteristics of active duty servicemen are very different from those of civilians (Dobkin and Shabani, 2009). Furthermore, active military service is not random in relation to the men's education, socio-economic status, employment status, marital status, or race—all variables known to be linked to mental health. Moreover, high socio-economic status is negatively related to the probability of joining the armed forces (Segal et al., 1998; Bachman et al., 2000; Kleykamp, 2006). At the same time, however, high socio-economic status is positively related to mental health (Miech et al., 1999), and lower educational achievements and low IQ scores are considered risk factors for PTSD (Macklin et al., 1998). Studies comparing deployed and non-deployed soldiers—e.g. (Shen et al., 2010; Wells et al.,

2010; and Smith et al., 2008)—may suffer from a lack of information about why soldiers are not deployed or why they are deployed to different areas of conflict.

To handle this selection bias problem, some researchers have tried to find instrumental variables that could influence the decision to join the army without influencing the outcomes. Hearst et al., (1986), the first to use the draft lottery as an instrument, provide lottery-based estimates of delayed effects of active military service on mortality. They implicitly assume treatment homogeneity among people who were exempt from the draft but who nonetheless volunteered, people who were draft-eligible, and people who were drafted. Angrist and coauthors also identify returns in education, training, and health by using the draft lottery as an instrument (Angrist, 1990, 1998; Angrist and Krueger, 1994; Angrist and Chen, 2011; Angrist et al., 2010).

Despite the use of the same instrument, results vary with the choice of the cohorts or the sub-sample. For example, Hearst et al., (1986) find draft exposure associated with an increased risk of suicide and automobile accidents, Conley and Heerwig, (2009) using records from the Vietnam draft lottery, find no effect of draft exposure on mortality—not even for cause-specific death rates.

To identify the causal effect of combat exposure on psychological well-being, Cesur et al., (2013) use exogenous variation in the location of overseas deployment assignment. However, although exposure to combat is random among soldiers on the same mission, especially in the new type of war such as that in Afghanistan (and to some extent that in the 1990s in the former Yugoslavia), a selection nonetheless occurs for sending troops on different missions, e.g., peace-enforcing or peace-keeping. Thus comparing units of soldiers staying home or being sent on other missions does not necessarily provide a counterfactual for the deployed units.

Another research difficulty is that of measuring mental health. Many studies (Autor et al., 2011; Whyman et al., 2011; Conley and Heerwig, 2011; Gade and Wenger, 2011; and Cesur et al.,

2013) rely on survey data that may suffer from non-response bias.[5] Other studies use administrative records, but indirect measures of health among veterans (Autor et al., 2011 and Angrist et al., 2010), making disentangling causes difficult. For example, Autor et al. (2011) find evidence of a recent increase in disability uptake in the U.S. but cannot distinguish whether this effect is driven by a long-term adverse health effect of combat or by a recent liberalization in benefit rules. Previously, Angrist et al. (2010) had found a greater disability take-up among Vietnam veterans with low earning potential. Again disentangling whether soldiers with low earning potential were more likely to experience combat during their service (see MacLean, 2011)—and therefore have a higher disability take-up—or whether the differences are due to the liberalization in the benefits rules may be difficult.

In addition, Kleykamp (2013) emphasizes that neglecting to account for soldiers' heterogeneous backgrounds may make identifying differences in the consequences of active military service across diverse groups impossible. Moreover, Gade and Wenger (2011) suggest that the time lag in the reporting of adjustment problems may be the result of the tendency for mental disorders to worsen in the absence of relatively immediate treatment. Therefore, and importantly, using longitudinal data over a long period allows us to see changes over time.

For many studies, information on where or how soldiers served is not always available. The unavailability of such data makes it difficult for researchers to distinguish for example, Vietnam-era veterans—including those who never served in Vietnam—from "boots on the ground" Vietnam veterans. Our having access to soldiers' military records, indicating the type and the number of missions, allows us to observe the full population of deployed soldiers.

[5] Indeed, combining survey data with administrative records (Lyk-Jensen et al., 2012a) shows that soldiers who do not answer surveys are usually overrepresented among those soldiers recorded in health registers as having a mental disease.

This literature review emphasizes the challenges involved in measuring the impact of military deployment on soldiers' mental health.

One clear strength of our study is the quality of the data we use, as it allows us to control for many relevant parameters unavailable to the other studies, e.g., administrative records over several years, describing socio-economic background and objective measures of mental health and ability measurements, such as the AFQT. We therefore use a subset of the male population that is eligible for military service (eligible men) as a starting point for establishing a comparison group. Both soldiers and eligible men are subject to the same set of eligibility screens. Those with either physical or mental health limitations are in principle excluded. Furthermore, as studies on mental health show a correlation between socio-demographics and mental health, we control for socio-demographics and mental health from the period before the men start any military duty. This data improves the comparability between soldiers and the comparison group. We therefore have a unique opportunity to select eligible men who resemble the soldiers on a large number of characteristics such as AFQT, pre-deployment objective health measures, and socio-demographic characteristics. As opposed to previous studies, we can follow the full population of eligible men (deployed or not), and we have very detailed information on the soldier's status and mission experiences. Furthermore, we have access to administrative records, we can thus avoid the non-response bias and measure mental health directly through diagnoses and purchase of mental health-related medication.

3. The Health and Military Systems

3.1. The Danish military system

Unlike the U.S. and other European countries, Denmark does not have a professional army. Instead, attendance at Armed Forces Day (AFD) is mandatory for all men when they become 18[6]—and, since 2004, women have also been invited to participate. Before the mandatory AFD meeting, all

[6] Actually it is possible to postpone the examination at AFD, therefore men are not necessarily 18 years when they are assessed. We therefore control for age in the propensity matching.

prospective draftees fill out a health questionnaire that forms the basis for a health assessment. The military physician can, if necessary, seek additional medical information from public health records prior to AFD. On AFD, prospective draftees undergo a medical examination and assessment, a psychological evaluation and a Børge Prien IQ test (AFQT)[7]. They are then declared eligible or non-eligible. On average, 60 to 70 percent of a birth cohort is declared eligible. Only men declared eligible can participate in the draft lottery, which inducts men into military service. After military service, only volunteers can be deployed[8].

On average, 7,000 men do their military service each year, and until January 1, 2006, the length of military service was on average eight months. Since January 1, 2006, military service has been called "Hærens Basisdddannelse" (HBU or basic military education) and constitutes on average four months of military education that can be followed by a voluntary eight months of further military training, the "Hærens Reaktionsstyrkeuddanelse", HRU or Military Reaction Forces education). This additional training prepares conscripts for deployment on international military missions as privates. Officers tend to bypass HBU and go straight to a four-year military training college. During 1992–2009, the Danish army sent an average of 2,000 to 4,000 soldiers on international military missions every year.

These soldiers sign contracts of varying lengths. From 1994 to 2005, the Danish International Brigade (DIB) was a peace-keeping force offering a three-year contract for international missions. Most of the soldiers deployed during 1994–2009 were recruited through this DIB contract. The shortest current contract is called K3, i.e. a contract for three years; there are also contracts up to age 35 (K35), or age 60 (K60), the latter usually held by permanent personnel with a contract up to

[7] The test has been used for more than 50 years (Teasdale, 2009; Teasdale, Hartmann, Pedersen, and Bertelsen, 2011). Teasdale et al. (2011) both assess the test-retest reliability and the possible negative effects of either lack of motivation or under-performance among the men taking the test.
[8] Likewise, throughout the Vietnam era most soldiers were also volunteers (Angrist and Chen, 2011).

retirement age. Thus in Denmark a soldier can serve for a short period and then return to civilian life after one deployment, after three years of service, or at age 35.

Although soldiers know which kind of military mission they are likely to be sent on at the time they volunteer, soldiers who enrolled in 2000 could not anticipate the forthcoming missions to Iraq and Afghanistan. While soldiers can always turn down a mission, either by cancelling the contract or resigning, they generally do not have a free choice of mission. The choice depends on how many missions are available and how many deployments are planned for each mission. Thus a new volunteer soldier in 2005, had a higher chance of being sent to Afghanistan than to the Balkans.

3.2. The Danish health care system

Although the armed forces have their own medical service in the form of "Military Health" (*Forsvarets Sundhedstjeneste,* FSU), this is not an alternative parallel system to the civilian health system (or National Health Service, NHS), as soldiers are treated in the same hospitals as civilians where they have access to the same GPs and specialists. While serving in the Danish Armed Forces (DAF), soldiers have access to military doctors, so the NHS records provide a lower bound. However, access to treatment in hospital is possible only through the NHS. Soldiers thus are formally recorded with a psychiatric diagnosis either as acute emergency cases or through contacts to hospitals (admissions or day patients) via prescriptions from GPs, specialists or military doctors.

Prescription drugs are heavily subsidized in Denmark. Moreover, people living in Denmark have access to a GP, with expenses covered by the NHS. In the period analyzed, Danish soldiers did not have special health insurance. Before, the Danish veterans' policy (October 2010), the NHS had neither focused on nor been particularly aware of soldiers' mental health impairment. [9] As a consequence, over-reported is not an issue for soldiers and the results will provide a lower bound.

[9] Ways of recognizing PTSD changed only in 2013. The Danish Ministry of Defense has acknowledged that the Danish involvement in international military missions has changed so

4. Data and descriptives

4.1. Data

The dataset comprises administrative records from the Danish Defense. The military register dataset contains longitudinal information on the whole population of deployed from 1992 to 2009, i.e., 26,000 soldiers and the entire population of eligible men (deployed eligible men, i.e., soldiers and non-deployed eligible men) from 1994 to 2010, a total of more than 300,000. This information includes the results for the ability and physical tests (AFQT and health profile[10]) and is available for the soldiers and non-soldiers born between 1975 and 1982[11]. We therefore restrict our sample to eligible men born between 1975 and 1982.

From the army administrative records we also have information on the number of missions, and the mission's place, date, and type. The date of the mission allows us to determine the pre- and post-deployment periods for the military deployment: before and after the first mission.

Because of the unique Danish civil registration number for each individual, the administrative Danish military records are linked to a huge variety of socio-demographic characteristics (e.g., education, social affiliation, health and medical care, death and cause of death, migration, employment, unemployment, income) from Statistics Denmark.

4.2. Deployment experiences

During the period 1992–2009, the DAF underwent major changes, moving from participation in peace-keeping missions to participation in peace-enforcing missions. At the same time, deployments on international missions shifted from being occasional to being the norm. Soldiers deployed in the 1990s often reported that feelings of powerlessness and studies show that operating

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rapidly that neither the DAF nor NHS had been aware of the consequences of deployment on soldiers' mental health.

[10] The health profile assesses six physical factors: back, arm, leg, vision, hearing, and other.

[11] However, the data are not fully representative for the 1975 cohort.

under difficult and restrictive rules of engagement adversely affected mental health (see Asmundson et al., 2002; Halverson et al., 1996; Litz et al., 2002; Orsillo et al., 1998; and Wong et al., 2001). Moreover, they usually reported adjustment problems with a time lag. Gade and Wenger (2011) suggest that this time lag may be the result of the mental disorders worsening because the soldiers were not treated soon enough after exposure.

From the data, we can also distinguish the one-time deployed from the many-time deployed—data providing information on the intensity of war exposure (see table A.1 in the appendix).[12] The deployed born between 1975 and 1982 were mainly deployed between 1996 and 2009 (see table A.2 in the appendix), when the main missions from 1996 to 2009 were Balkans missions.[13] Fewer were deployed to Afghanistan and Iraq, where operations were started in 2002 and 2003, respectively (see figure A.2 in the appendix).

4.3. Mental health measures

Measuring mental health is more difficult than, for example, measuring earnings and most studies have used indirect measurements (disability status) or self-reported health measures. To proxy mental health, we use the objective measures of psychiatric diagnosis, and the purchase of mental health-related medication.[14] These measures proxy more precisely mental health care use, but we will refer to them as a proxy to mental health. The remainder of this subsection describes the objective measures for mental health. Both measures derive from administrative records and were available in the period 1995–2010.

[12] Unfortunately, the data we had access to do not encompass information on combat units. As a consequence we focus on the effect of deployment and not combat as intensity of exposure can only be inferred at the team level. However, we will look at heterogeneous effects by mission country.
[13] Note that one time-deployed have not necessarily left the DAF, they are just recorded with one deployment in the analyzed period (1996-2009).

[14] We did not include substance abuse treatment, as Lyk-Jensen et al., (2012b) show that most of the persons recorded with a substance abuse treatment were already recorded with either a psychiatric diagnosis or a purchase of mental health medication.

The Danish Psychiatric Central register encompasses all contacts with psychiatric hospitals since 1938 (see, e.g., Munk-Jørgensen and Mortensen, 1997; Hageman et al., 2008). This data has been computerized since 1969. Moreover, from 1995, out-patient contacts are also recorded.[15]

We use the World Health Organization International Classification of Disease, version 10 (WHO ICD-10 classification system) in the analysis.[16] For each year we considered in the analysis we look at whether the person has a diagnosis and, if so, what type it is.

The first column in Table 1 shows the categories of psychiatric diagnoses we use for comparing deployed and non-deployed eligible men. These specific mental disorders are relevant to analyzing soldiers' mental state after deployment. We are interested in not only the number of diagnoses, but also their type, because the prevalence of mental health impairment could on average be higher in the comparison group, while the prevalence for specific diagnoses could be higher for the soldiers.

[15] The Danish Psychiatric Central Register does not contain psychiatric diagnoses from GPs or psychiatric specialists who practice outside hospital settings. This data restriction constitutes a minor issue, as we can observe medical prescription from GPs and specialists. Thus we underestimate psychiatric morbidity.

Table 1

Psychiatric diagnosis (WHO-ICD-10) and drug groups defined as mental health-related medication for the analysis.

Psychiatric diagnosis according to World Health Organization International Classification of Disease, Version 10		Drug groups defined by mental health-related medication	
Diagnosis	Code	Drug preparation: Nervous system medicine (NS-drugs)	ATC codes
Organic, including symptomatic, mental disorders[1]	F00-09	Antipsychotics	N05A
Mental and behavioral disorders due to psychoactive substance use	F10-19	Anxiolytics and hypnotics	N05B
Schizophrenia	F20	Sedatives	N05C
Schizotypal and delusional disorders	F21-29	Antidepressants	N06A
Mood [affective] disorders [2]	F30-39	Psychostimulants and nootropics [5]	N06B
Neurotic, stress-related, and somatoform disorders [3]	F40-48	Drugs used in alcohol dependence	N07BB
Behavioral syndromes associated with physiological disturbances and physical factors	F50-59		
Disorders of adult personality and behavior [4]	F60-69		
Other F-diagnosis			

Notes
1) The war in Iraq introduced a new military syndrome: Mild Traumatic Brain Injury (MTBI). Although the diagnosis is labeled somatic, it is identical with the psychiatric diagnosis of postconcussional syndrome (ICD-10: F07.2).
2) In this category we are particularly interested in depressive episodes (F32) and recurrent depressive disorder (F33).
3) This category includes reaction to severe stress and adjustment disorders (F43), including PTSD (F43.1).
4) In this category we are particularly interested in enduring personality change after catastrophic experience (F62.0).
5) We have very few in the analysis.

To identify purchases of mental health-related medication, we use data from the Danish Register of Medicinal Product Statistics (*Lægemiddelsdatabase*) from 1995 to 2010. The register contains information on sales of drugs prescribed by GPs, specialists or military physicians. These sales are reported by the pharmacy where the medicine was sold.[17]

[17] When we describe the purchase of medication per person, we refer to the number of prescriptions written by the GP (the primary sector), because hospitals (the secondary sector) do not record the

The drugs are classified according to an international system, the ATC classification system (Anatomical Therapeutic Chemical). We focus on medicine used for treating mental illness, i.e., drugs acting on the nervous system (NS-drugs). This information provides another measure of the individual's mental health. The ATC classification system allows us to relate drugs to the relevant diseases.

We have selected the following medications for mental disorders: antipsychotics, anxiolytics, hypnotics, sedatives, and antidepressants.[18] We have also added psycho-stimulants and anti-alcohol addiction, both of which may also help us identify the consequences of deployment on mental health. The second column of Table 1 shows the ATC codes for the selected drugs included in the analysis.

We pool these pharmaceutical drugs into one group—which we denote "NS- drugs"—as there may be substitution and complementarity between the different types of medication for mental disease. The variable of interest here is the purchase or not of the selected drugs for each year in the period 1995–2010.

The following sections investigate whether the purchase of NS-drugs and recorded psychiatric diagnoses are different for the group of soldiers and eligible men. In the analysis, we combine these two measures for mental health.

4.4. Descriptive Statistics and Original Sample

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purchase of medication on the patient's personal identification number (CPR number). Soldiers can also obtain medicine from the Military Health Service (FSU). As long as the medication is prescribed, it will appear in the registers and in our computations. However, if it was delivered directly to the patient, we cannot see it in the registers.

[18] We have also looked at analgesics (ATC code N02), as specific patterns might appear in the form of overconsumption among the soldiers. However, we did not detect a specific pattern in the use of analgesics.

As mentioned earlier, we have data for the full population of Danish soldiers deployed between 1992 and 2009, and we have a longitudinal database for this population on socio-demographics and health characteristics. Furthermore, we have military characteristics such as the missions they have been sent on, and the number of missions they participated in. We then compare the deployed and non-deployed eligible men born 1975-1982.

By looking at different cohorts of eligible men (i.e. having similar initial health) from the Danish military draft board register, we can easily rule out the survivor bias described in Seltzer and Jabon (1974)—that soldiers often live longer than the rest of the population because of their initial better health. The non-deployed eligible men therefore constitute a powerful comparison group. Moreover, using characteristics prior to the AFD year, together with the AFQT, can further improve the comparability of the two groups.[19]

War-related deaths are not expected to constitute an important source of bias. Since 1992, about 60 Danish soldiers have died, and 300 have been physically injured during military deployment.[20] To ensure that possible differences between the two groups are not due to changes in the sample during the period, we exclude deaths (including war-related deaths and post-service mortality), as well as persons who immigrated or emigrated during the 16-year analysis period (1995–2010).

For the 26,000 deployed soldiers, we observe that soldiers deployed in the 1990s to the former Yugoslavia usually have worse mental health, measured in terms objective mental health measures, than the entire population of soldiers. [21] However, those soldiers are excluded from our sample, which is restricted to those born between 1975 and 1982 and deployed from 1996 to 2009—about

[19] Many studies show that physical and mental health are correlated. Thus physical and ability tests are important covariates for describing soldiers and their counterparts.
[20] See figure A.4 in the appendix for the number of dead, wounded and returnees in the period 1996-2009 by mission.
[21] For the full population of soldiers, we find that 17 percent of the 26,000 soldiers are recorded with mental health problems after their first deployment. These soldiers were not recorded with these mental health problems before their first deployment (measured in 1995–2010).

6,778 soldiers. Given that soldiers could be deployed more than once during the 1996–2009 period (43 percent were deployed only once in that period and 57 percent were deployed more than once) (see table A.1), and that they were deployed at different times, we chose the first deployment year for determining the periods *before* and *after* deployment.[22]

When we compare birth cohorts (1975–1982) for deployed and non-deployed eligible men from the AFD data (see table 2), we find that the soldiers are on average older, mostly ethnic Danes, more often raised in a single-parent family, and more often experienced placement in out-of-home care as a child. Soldiers deployed more than once (i.e., the many-time deployed) participated in two to more than nine military missions (see table A.1 in the appendix). To start with, we focus our analysis to the one-time deployed soldiers, as their experience (one deployment) is less heterogeneous.[23] However, we will also include the many-time deployed in our sensitivity analysis section. When we compare pre-AFD characteristics of the one-time and the many-time deployed, we find that one-time deployed belongs to older cohorts than the many-time deployed and have a higher score at the AFQT. While after deployment, the one-time deployed are recorded more often with a psychiatric diagnosis or the purchase of mental health-related medication

The last rows of Table 2 show our mental health measurements during the analysis period. For most of the soldiers, these health measures are recorded after deployment and therefore endogenous. Furthermore, they do not account for the pre- and post-deployment periods or the selection bias. The comparison group of non-deployed eligible men show worse mental health, i.e., more diagnoses and higher purchase of mental health-related medication than the deployed men.

[22] By convention the deployment year belongs to the post-deployment period.
[23] See the different mission experience for both the one-time and the many-time deployed in Figure A.2 in the Appendix.

Table 2

Socio-demographic characteristics and health measures for deployed (the one-time and the many-time) and non-deployed born 1975–1982. Percent.

		Deployed soldiers				Non-deployed eligible men
	A-B	A	B	C	C-D	D
		One	Many	Total		
Born in 1975		16.7	16.6	16.0	***	8.2
Born in 1976		14.2	13.9	14.0	**	13.1
Born in 1977	**	14.3	12.0	13.0	**	14.0
Born in 1978	**	13.0	11.9	12.4	***	14.1
Born in 1979		12.4	11.6	12.0	***	13.7
Born in 1980	***	9.3	13.0	11.4	***	13.2
Born in 1981	***	8.9	11.7	10.5	***	12.0
Born in 1982		11.3	10.3	10.7	**	11.8
Average age in years	***	23.3	22.7	22.8	***	22.4?
Immigrant		1.6	1.7	1.6	***	3.4
Placement in out-of-home care as a child		4.6	5.4	5.1	***	3.9
Raised in single-parent family		20.5	21.4	21.0	***	17.4
Psychiatric diagnosis between 1995–2010	***	6.2	4.3	5.1	***	6.1
Purchase of NS-drugs between 1995–2010	***	16.6	13.2	14.6	***	17.0
Number of observations		2,915	3,863	6,778		104,790
Average no. of tasks solved at the AFQT (2)	**	45.06	44.42	44.7		44.6

Chi^2 test and t-test ***p<0.01; **p<0.05; *p<0.10. A-B-compares one-time (A) and many–time (B) deployed. C-D compares deployed (C) and non-deployed (D).

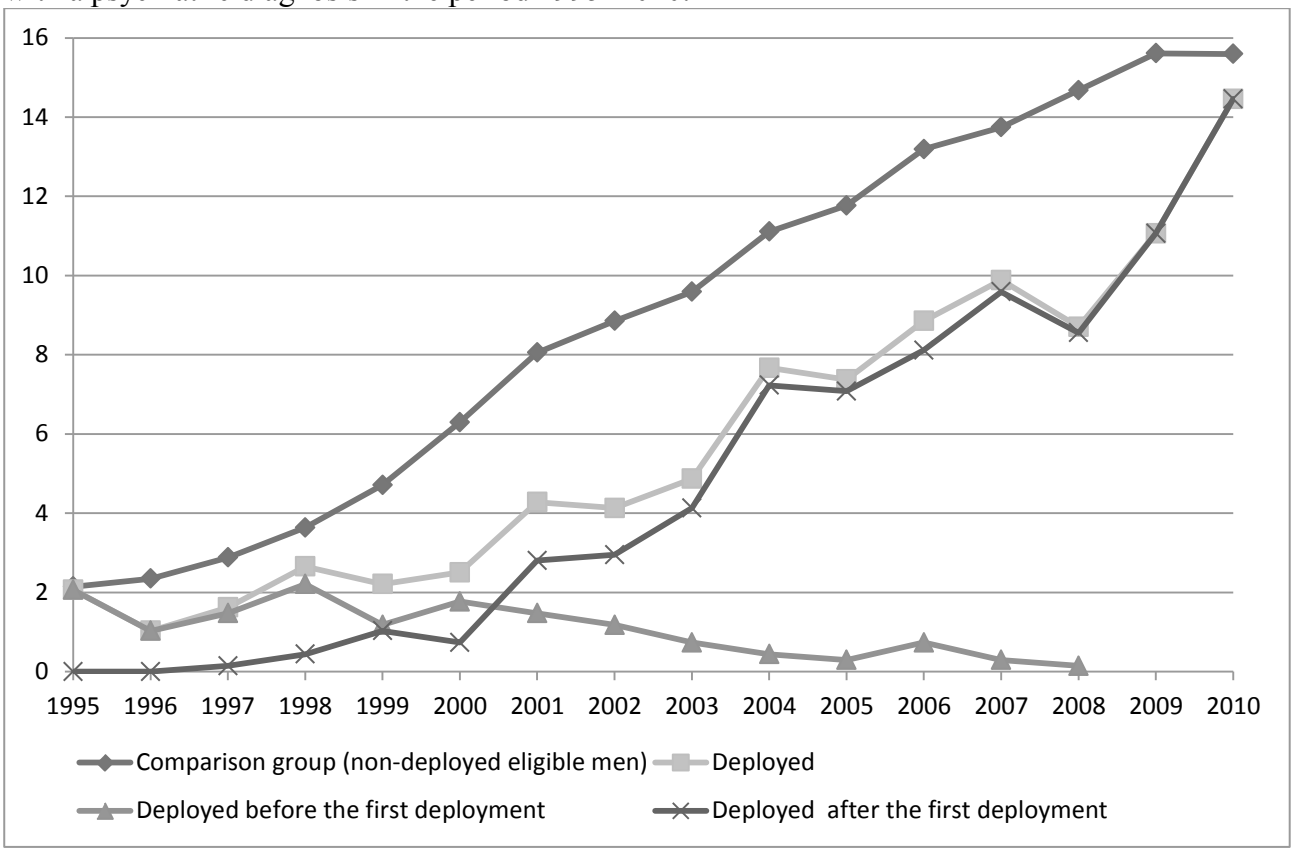
(1) Only computed for the men with an AFD year and an AFQT.

(2) Results from the AFQT: number of tasks solved out of the 78 questions. Only available for 6,229 soldiers out of the 6,778.

Figure 1 illustrates the difference in recorded psychiatric diagnoses in the period 1995–2010 for both the deployed and the non-deployed eligible men. It shows that the soldiers generally have fewer psychiatric diagnoses. We also know that they purchase less NS drugs (see table 2). These findings illustrate the "healthy warrior effect" mentioned earlier (Larson et al., 2008). Figure 1 therefore reflects the positive selection of the deployed, as fewer have a psychiatric diagnosis. Furthermore, for the deployed men, Figure 1 distinguishes the pre- and post-measurements showing

that the prevalence of psychiatric diagnoses before deployment decreases between 1995–2010.[24] This tendency may illustrate a change in the standard for the army's selection during this period. Figure 1 also shows the increase in recorded psychiatric diagnoses after the first deployment.[25]

Figure 1
Per thousand of the population of deployed and non-deployed born in 1975–1982 recorded yearly with a psychiatric diagnosis in the period 1995–2010.



5. Empirical strategy

The data description shows that the deployed and the non-deployed eligible men differ substantially in terms of pre-AFD covariates. Furthermore, the deployment is not fixed in time, and the deployed soldiers have been deployed in different years, thereby giving us different pre- and post-deployment

[24] Figure 1 shows that some soldiers may have received a psychiatric diagnosis before their first observed deployment in the period 1992-2009, as some soldiers may have been deployed before 1992 but we do not have this information.
[25] We obtain a very similar pattern for the purchase of NS-drugs. As the prevalence for psychiatric diagnoses is lower, we decided to show psychiatric diagnosis separately.

periods for mental health outcome measurement. From our large draft board dataset, we can easily select a group of eligible men having similar pre-deployment covariates to the group of deployed soldiers. However, we do not have a pre- and post-deployment period for the non-deployed eligible men and have to impute one. Therefore by using pair-wise matching, we can, not only make the two groups comparable, but also impute deployment dates for the non-deployed eligible men. Furthermore, we exploit the panel structure of the data in a difference-in-differences setting to control for time trends and other omitted variables affecting both the soldiers and the comparison group of eligible men.

5.1. The choice of the covariates

The choice of the covariates is crucial, as the unconfoundedness assumption in matching is based on the hypothesis that all the relevant covariates are controlled for. A meta-analysis of PTSD-related studies (Brewin, Andrews, and Valentine, 2000) shows that, depending on the studied population, factors such as gender, race, age, education, previous trauma, previous abuse and psychiatric history were highly predictive of PTSD symptoms. Furthermore, (Kessler et al., 2005) show that the starting age for some psychiatric diagnoses is usually early adulthood. These findings emphasize the importance of accounting for these covariates when mental health has to be measured.

As characteristics one year before the deployment could be considered endogenous, reflecting the results of entering the military system, we use covariates measured during the AFD (i.e. before deployment and induction).[26] We use covariates such as AFQT, ethnicity, the person being recorded or not as having a psychiatric diagnosis or buying NS-drug up to the year of the AFD,

[26] The soldiers are on average deployed three years after the AFD. However, when we estimate the model with variables one year before deployment, the main results do not change. [27] For the men cohorts 1975-1976, we first observed the health measure from age 20 and 19 respectively.

variables indicating how the person lived until age 17 (e.g., placement in out-of-home, raised in a single-parent family), and year of birth. [27]

5.2. Matching soldiers and eligible men: Estimation sample

Brewin et al. (2000) and Kessler et al. (2005) show that many covariates may influence mental health, meaning that it is important to control for them when comparing the soldiers' mental health before and after deployment with a group of eligible men. To construct a counterfactual for the deployed soldiers, we also need to have a pre- and post-period for the comparison group of eligible men. Although matching does not fundamentally differ from a fully saturated OLS model (see Angrist, 1998), the main reason for using it, is to impute the counterfactual year of deployment of these matched non-deployed eligible men using the deployment year of the comparable deployed. Consequently, as in Becker and Hvide, (2013) we use matching not only to identify comparable men born in the same year as the deployed and having the same socio-demographic and health profile, but also to impute the counterfactual year of deployment for the non-deployed matched eligible men. We use the first mission as the cut-off point for the before and after periods. The pre-deployment period is defined as the years before the first deployment, while the post-deployment period includes the first deployment year. We use annual data. Thus we can infer what would have happened to the mental health of the deployed had they not been deployed.

The propensity score used in the matching is the probability of military deployment conditional on pre-AFD characteristics, i.e., it selects eligible men, whose *ex ante* probability of being chosen for a deployment is closest to that of the 2,664 one-time deployed soldiers. [28]

[27] For the men cohorts 1975-1976, we first observed the health measure from age 20 and 19 respectively.

[28] From the original sample of 2,915 one time-deployed in Table 2, we excluded 251 persons for whom AFQTs or conscription years were unavailable.

As we use AFQT to match the deployed with the non-deployed eligible men, we had to exclude 549 soldiers from the analysis.[29] However, only selecting those soldiers with AFQT improves the comparison group and the conclusion. Having AFQT as observable matching variable—usually not-observed or not available in other studies—increases the quality of the matching. We also investigated mental health measures up to the AFD year (observed for both groups) to select the non-deployed, thus avoiding systematic differences between the deployed and non-deployed up to the conscription year.

To reduce the problem associated with matching on a multidimensional covariate vector (Rosenbaum and Rubin, 1983), we use a probit specification to estimate the propensity score. Given the estimated propensity score matching, we use nearest-neighbor matching (without replacement) to combine deployed men and eligible men.[30] We run a probit model of being deployed on pre-deployment characteristics (i.e., characteristics measured in the AFD year) and obtain propensity scores for all 2,664 soldiers and for the 104,741 eligible men[31]. The results are reported in Table A.3 in the Appendix. Ex ante the deployed men represent 2.5 percent of the sample. We impose exact matching on the birth year to ensure that we compare pairs of deployed and non-deployed eligible men who are the same age in the same calendar year.

5.3. Results from matching

[29] We investigated the outcome for these 549 soldiers and found that they usually have basic education, were deployed in the 1990s in the former Yugoslavia, and usually have more psychiatric diagnoses than the soldiers for whom we had an AFQT. Thus removing them from the sample likely weakens the effect of deployment on mental health.

[30] To perform propensity-score matching and covariate balance testing, we use a version of Edwin Leuven and Barbara Sianesi's Stata module psmatch 2 (210, version 4.0.4, http://ideas.repec.org/c/boc/bocode/s432001.html).

[31] For some eligible men the conscription year was also missing. We therefore excluded those individuals (49 out of 104,790) from the analysis.

Compared to Table 2, Table 3 shows that matching manages to largely remove the pre-AFD differences between the two groups on observable characteristics. Column 7 shows no significant differences in the pre-deployment characteristics between the matched one-time deployed and the non-deployed eligible men.

Table 3

The matched sample for the one-time deployed and the non-deployed eligible men.

	Deployed		Matched non-deployed		Total		Differences
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Raised in single-parent family	0.201	0.401	0.200	0.400	0.200	0.400	n.s.
Placed in out-of-home care as a child	0.042	0.201	0.038	0.191	0.040	0.196	n.s.
Immigrant	0.016	0.126	0.016	0.125	0.016	0.125	n.s.
AFD year	1.998	2.575	1.998	2.557	1.998	2.565	n.s.
Year of birth	1.978	2.222	1.978	2.222	1.978	2.222	n.s.
No. of tasks solved at the AFQT on average	45.053	7.903	45.213	7.831	45.133	7.866	n.s.
Psychiatric diagnosis up to AFD year	0.007	0.002	0.006	0.001	0.006	0.001	n.s.
Purchase of NS drugs up to AFD year	0.030	0.170	0.032	0.175	0.031	0.171	n.s.
No. observations	2,664		2,664		5,328		n.s.

Column (7) shows whether there are significant differences between deployed and non-deployed. Chi^2 test and t-test

***p<0.01; **p<0.05; *p<0.10.

We re-run the propensity score specification on the matched sample, i.e., the 2,664 one-time deployed and their 2,664 matched controls. The median absolute standardized bias (see Rosenbaum and Rubin, 1985) drops from 5.6 before matching to 1.1 after matching, hence the two groups are very similar.

5.4. Before & after changes in mental health

To analyze whether a deployment has a causal effect on the mental health of individuals, we compare whether individuals who are experiencing a deployment are more subject to experiencing mental health deterioration. Our main interest relies on differences after exposure between two similar groups of men. However, we are also interested in mental health differences in the two groups before the exposure, as previous mental health is a good predictor of future mental health. Table 4 shows that the deployed have significantly more mental health problems—measured with the combined measures—during the post-deployment period (i.e., 80 percent of all mental health problems for the deployed men) than the matched non-deployed eligible men (72 percent of all mental health problems). Results about psychiatric diagnoses show that 4.6 percent of the deployed men and 3.7 percent of the eligible men in our matched sample are recorded with a psychiatric diagnosis in the post-deployment period. However, when we look at the combined measures of psychiatric diagnosis and purchase of NS-drugs, the percentages for post-deployment mental health problems are 24.2 percent for deployed men and 20.3 percent for eligible men in the matched sample.

Table 4

Descriptives for pre- and post-mental health measurements for deployed and non-deployed. Number and percent. Matched sample with imputed deployment date.

	Psychiatric diagnosis		Combined health measures	
	Deployed[32]	Non-deployed	Deployed	Non-deployed
Only before	27	23	85	104
Before and after	7	13	78	109
Only after	123	98	646	541
None	2,507	2,530	1,855	1910
Total	2,664	2,664	2,664	2,664
Recorded after deployment (percent)	4.6	3.7	24.2	20.3
Recorded both before and after (percent)	5.9	5.0	30.4	28.3

Note: The matched sample includes the 2,664 deployed and the 2,664 matched eligible men. A matched date means that within a matched pair the deployment year for non-deployed is imputed from the corresponding matched deployed. The combined health measures include psychiatric diagnosis and purchase of NS-drug. Variables used in the matching procedure are: single in AFD year, raised in single-parent family at age 17, placed out-of-home care as a child up to 18 years, immigrant, AFD year, year of birth, no. of tasks solved at the AFQT on average, psychiatric diagnosis and purchase of NS-drug up to AFD year.

Not only the period in which the individual receives a diagnosis (pre- and post-deployment) but also the type of diagnosis is important. Table 5 shows the highest ranked diagnosis[33] distinguishing the pre- and post-deployment periods. It shows that stress-related diagnoses (F40-49, including PTSD) constitute the predominant diagnosis for the one-time deployed. From pre- to post-deployment, the number of individuals with a stress-related diagnosis is multiplied by more than five for the deployed men and by four for the non-deployed eligible men.

[32] The diagnosis can be recorded between birth and the AFD examination. These diagnoses are not necessarily known for the physician at the AFD. Moreover, a person recorded with for example ADHD diagnosis but without taking medication can be declared eligible.

[33] World Health Organization (2004). We rank the psychiatric diagnoses according to their severity (i.e., F00-09>F20>F21-29>F30-39 … >F90-99>F10-19). Similarly to Hageman et al. (2008), we choose to categorize "Mental and behavioral disorders due to psychoactive substance use (F10-19)" as secondary to other diagnoses. However, if F10-19 is the soldier's only diagnosis, its position in the hierarchy is given by the diagnosis number.

Table 5

Descriptives for type of diagnosis before and after. Per thousand.

	Deployed		Non-deployed	
	Before Per. 1000	After Per. 1000	Before Per. 1000	After Per. 1000
F00-29: Organic, including symptomatic, mental disorders F20: Schizophrenia, F21-29: Schizotypal and delusional disorders, Mood disorder	1	3	2	6
F30-39: Mood disorder	2	13	2	8
F40-49: Stress related	4	20	3	12
F50-59: Behavioral syndromes	0	2	1	1
F60-69: Disorder of adult personality	2	4	1	5
F10-F19: Substance use	1	3	1	6
Other diagnoses	4	3	4	5
Total	13	49	14	42

Note: The table shows per thousand, for men recorded with some selected psychiatric diagnoses, i.e., the most severe recorded diagnosis in the period according to the diagnose hierarchy. Diagnoses F00 to F29 are grouped because of low frequencies.

6. Estimated effect of deployment on mental health: Difference-in-differences set-up

To estimate the effect of deployment on mental health, we conduct difference-in-differences analyses. The key assumption of the difference-in-differences model is that the average change in the outcome is presumed to be the same for both the eligible men and, counterfactually, for the deployed men *had they not participated*. In other words, we assume that unmeasured factors, changes in economic conditions or other policy initiatives, affect both the deployed and eligible men in similar ways. As in Becker and Hvide (2013), we conduct our difference-in-difference analyses on the matched sample of deployed and eligible men. We run a regression for changes in mental health for the two groups (5,328 men observed in 16 years).

To investigate the effect of deployment on mental health, we estimated equation (1) on the matched sample, where the dependent variable *psy* denotes a combination of the two objective

measures for mental health (psychiatric diagnosis and purchase of NS-drugs) and equals to 1 if person *i* is recorded with either psychiatric diagnosis or medication purchase in year *t*.[34]

$$psy_{it} = \beta_0 + \beta_1 deployed_i + \beta_2 after_{it} * deployed_i + \beta_3 after_{it} + \gamma X_i + \delta_t + \epsilon \quad (1)$$

deployed is a dummy variable, equal to 1, if *i* has been deployed, or else 0

after is a dummy variable equal to 1, if the observed period occurs after the deployment year or the imputed deployment year for the non-deployed eligible men. X_i is the matrix of variables that entered the original matching procedure, i.e., the characteristics of the men at AFD year (see table 3). To increase efficiency and adjust for any small residual bias, we control for the original matching variables. We also control for AFD year (δ_t).

We focus on differences after the first deployment year for the deployed and the imputed year for the non-deployed eligible men. Our parameter of interest is β_2 (in other words, the coefficient of the interaction term of being deployed and after deployment, i.e., deployed*after), which measures the difference between deployed and the non-deployed eligible men. Table 6 summarizes the results for models based on specification (1) comparing the deployed men with the matched sample of eligible men.

Column (1) in Table 6 shows the overall result, while columns 2-5 investigates heterogeneous effects for some covariates and column (7) decomposes the temporal effect by year.

Table 6 shows for all the specifications 1 to 7 that deployment has a significant adverse effect on soldier's mental health varying between 19 and 26 percent. The mean effect of deployment on mental health (i.e., the combined mental health measures) is 1 percentage point (see column 1). Thus given the sample mean for mental illness (4.2 percent), we obtain a 24 percent increase.

[34]We shows the results, where *psy* denotes psychiatric diagnosis only in our sensitivity analysis

Our results include coefficients on deployment ($\boldsymbol{\beta_1}$) and the period after ($\boldsymbol{\beta_3}$). The coefficient of overall deployment ($\boldsymbol{\beta_1}$) is significantly negative and small in all the seven specifications capturing the healthy warrior effect (about one percent at the sample mean). Given that eligible men are matched on their characteristics at the AFD and soldiers were usually deployed three years after the AFD, this small significant effect represents the healthy warrior effect, showing that military training in the form of HBU and HRU selects the strongest to be deployed (e.g. Hageman et al 2008). However, we had to use characteristics at AFD to avoid further endogenous selection. The DID setting allow to control for this level difference between the two groups. The coefficient of overall time effect ($\boldsymbol{\beta_3}$) is positive, meaning that over time the risk of mental health impairment nonetheless increases with age. The effect of deployment on mental health ($\boldsymbol{\beta_2}$) is significant showing an adverse effect on soldiers' mental health after deployment.

Table 6

Estimation results of the effect of deployment on mental health. Cohorts 1975–1982.

	Outcome: Combined mental health measures Sample: One-time deployed and matched non-deployed eligible men with matched dates for before and after						
	Main model	*Interaction of individual charateristics*				*Deployment country*	*Time variables*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Deployed	-0.007***	-0.008***	-0.006***	-0.008***	-0.005**	-0.007***	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
After	0.040***	0.038***	0.039***	0.040***	0.043***	0.042***	
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
Deployed*after	0.010***	0.011***	0.009***	0.010***	0.008***		
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)		
(1,2,3) years before deployment							-0.003
							(0.003)
Deployed*(1,2,3) years before deployment							-0.001
							(0.004)
(1,2,3) years after deployment							0.001
							(0.003)
Deployed*(1,2,3) years after deployment							0.003
							(0.004)
(4,5,6) years after deployment							0.001
							(0.003)
Deployed*(4,5,6) years after deployment							0.008***
							(0.004)
(7,8,9) years after deployment							0.004*
							(0.003)
Deployed*(7,8,9) years after deployment							0.008***
							(0.004)
Deployed*after * (Grew up in single parent family)		-0.003					
		(0.007)					
Deployed*after * (Placed in out-of-home care as child)			0.023				
			(0.014)				
Deployed*after * (AFQT score)				0.006			
				(0.015)			
Deployed*after * (Combined health measures up to AFD year)					0.032**		
					(0.015)		
after*deployed in Afghanistan						0.017**	
						(0.007)	
after*deployed in Balkans						0.012***	
						(0.003)	
after*deployed in Iraq						-0.004	
						(0.005)	
after*deployed in other countries						0.013**	
						(0.006)	
Adj. R2	0.02	0.02	0.02	0.02	0.03	0.03	0.015
No. Observations	85248	85248	85248	85248	85248	85248	35980
Sample mean for mental illness	0.042	0.042	0.042	0.042	0.042	0.042	0.047

Standard errors clustered at the individual level in parentheses: * p<10, ** p<0.005, *** p<0.01.

Note: The combined mental health measures include psychiatric diagnosis and purchase of NS-drug. The matched sample includes the 2,664 deployed and the 2,664 matched non-deployed eligible men. Matched date means that within a match pair the deployment year for non-deployed is imputed from the corresponding matched deployed. The controls include a matrix of variables that entered the original matching procedure (i.e., single in AFD year), raised in single-parent family, placed out-of-home care as a child, immigrant, AFD year, year of birth, no. of tasks solved at the AFQT on average. We exclude psychiatric diagnosis and mental health related medication up to AFD year to avoid having a lagged dependent variable on the right-hand side of the regression. However, results are unchanged if we include these. We use the following specification: $psy_{it} = \beta_0 + \beta_1 deployed_i + \beta_2 after_{it} * deployed_i + \beta_3 after_{it} * deployed_i * z_i + \beta_4 after_{it} + \gamma W_i + \delta_t + \epsilon$, where W_i is the matrix of the characteristics entering the matching procedure minus z_i.

To investigate heterogeneous effects, we interact binary indicators of individual's characteristics with the deployment and after*deployment dummies (columns 2-5). Previous studies have shown that growing up in an unstable environment increase the risk of becoming mentally ill (Miech et al., 1989). One might therefore assume that deployed men growing up with only one parent or experiencing out-of-home care placement have a higher risk of becoming mentally ill when they experience the extreme situations that accompany deployment. However, the results in Table 6 columns 2 and 3 show that growing up in an unstable environment has a negative but not significant effect on the risk of becoming mentally ill after deployment.

While Macklin et al. (1998) find that lower educational achievements and low IQ scores are risk factors for PTSD, our results on heterogeneous effect on individual's AFQT are positive but not significant (see column 4). However, deployed soldiers who had a psychiatric diagnosis before age 18 do have a higher risk for post-deployment mental illness (see column 5).

Unfortunately, the data we had access to do not encompass information on combat units. As a consequence we focus on the effect of deployment and not combat as intensity of exposure can only be inferred at the team level. However, we have information about the mission country, which we can exploit to investigate heterogeneous effects of exposure.

Column 6 in Table 6 shows that soldiers sent to the Balkans have 1.2 percentage points higher risk of becoming mentally ill than the matched non-deployed eligible men. One explanation may be that soldiers deployed to the Balkans were not prepared to witness such violence without being

allowed to intervene (see e.g., Orsillo et al., 1998). Moreover, Balkan soldiers received very little support and help post-deployment.

Table 6 column 6 also shows that we find the highest effect on mental health for soldiers deployed to Afghanistan (1.7 percentage points). Extreme war conditions for Afghanistan likely explain this result. Given that the effect on mental health may occur some years after the latest deployment, we can expect even higher incidences of mental illness for these soldiers in the future. In contrast, we find no significant effect on mental health for the soldiers sent to Iraq, compared to the non-deployed eligible men. One explanation could be that the degree of exposure was lower for these missions compared to Balkans and Afghanistan, reflected by a lower number of killed and wounded among Danish soldiers in Iraq, compared to missions in Afghanistan and in the Balkans (see figure A.4 in the appendix).

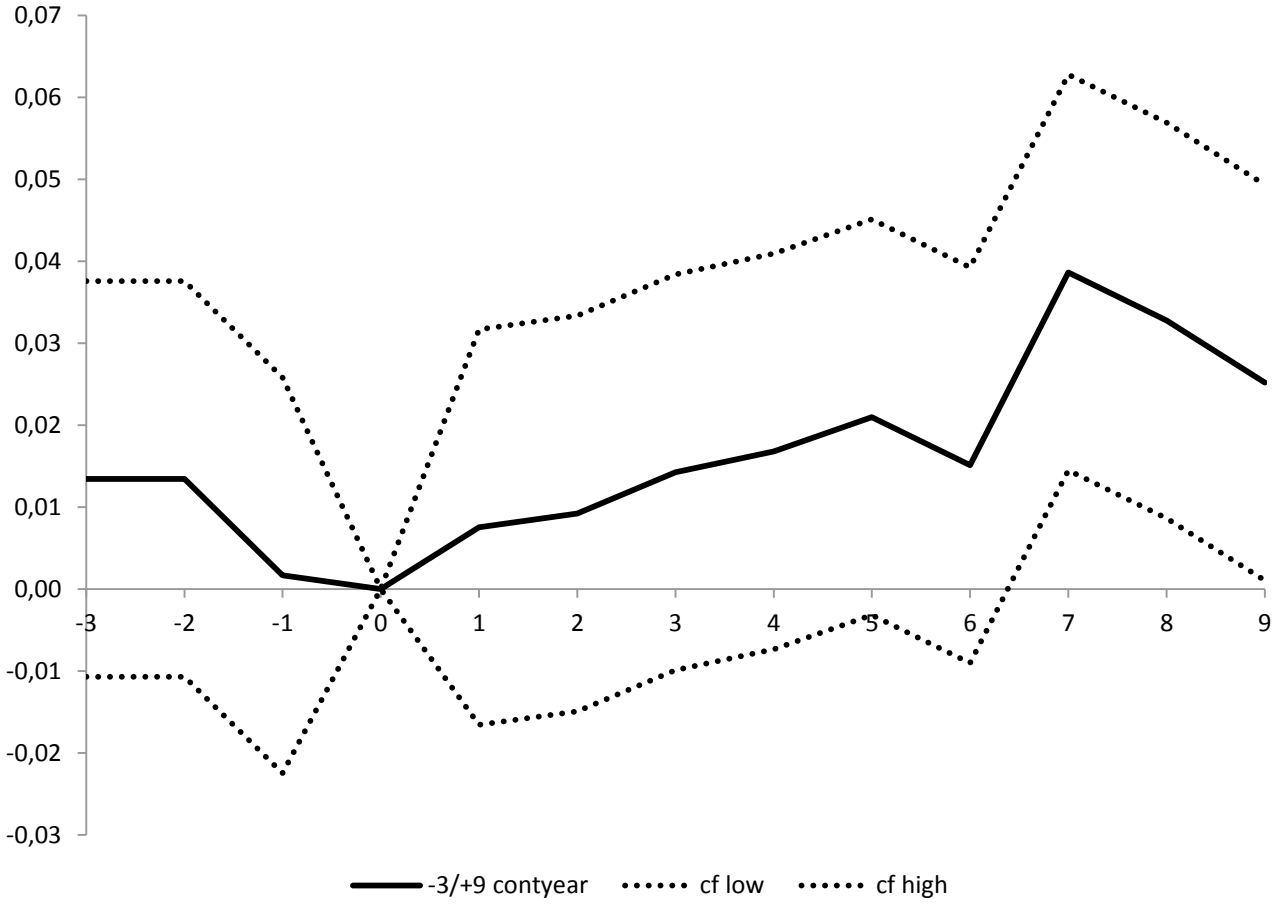
To illustrate how the results vary year by year, we decompose the effect by group of years pre- and post-deployment. However, as Figure A.3. in the Appendix illustrates, the number of observations is becoming very small if we consider long pre- and post-deployment periods. We have therefore restricted the sample to observations within the time window to 3 years before and 9 years after the deployment (reducing the sample from 85,248 to 35,980 observations). In Table 6 column 7, the interaction term after deployment is now split into 3-year intervals and illustrates in which period the mental health problems are most likely to occur. As expected, the results in Table 6 column 7 show no significant pre-deployment effects in the matched sample confirming that the two groups can be compared. The effect of deployment on soldiers' mental health is significant after 4 years, compared to the comparison groups of eligible men. Furthermore, as the effect on mental health is delayed it can also explain why soldiers deployed in the beginning of the analysis period—i.e., Balkans soldiers—have a higher probability of being recorded than soldiers more

recently deployed. Thus deployment increases mental health problems over the years since deployment.

Figure 2 illustrates the yearly effect of deployment on mental health for the matched sample of eligible men with an imputed random date and the sample of the 2,664 one-time deployed men, while Table 6 shows the results by 3-year intervals Consequently significance levels and parameters size in Table 6 and Figure 2 are different as the number of observations per year and for 3-year intervals are different. Nonetheless, Figure 2 also shows that deployment has a long-lasting effect on mental health as measured by psychiatric diagnoses and purchase of NS-drug and confirms the results of Table 6.

Figure 2

Estimated coefficients. The matched sample of eligible men with an imputed date and the sample of one-time deployed men born in 1975–1982 recorded yearly with a psychiatric diagnosis or purchase of NS-drugs in the period 1995–2010.



Note: The estimation coefficient comes from the matched sample of non-deployed eligible men with an imputed date and the sample of the 2,664 one-time deployed men. We restricted the period to 3 years before to 9 years after deployment/imputed deployment. The controls include a matrix of variables that entered the original matching procedure (i.e., single (AFD's year), raised in single-parent family, placed out-of-home care as a child, immigrant, AFD year, year of birth, no. of tasks solved at the AFQT on average. We exclude psychiatric diagnosis and mental health related medication up to AFD year to avoid having a lagged dependent variable on the right-hand side of the regression. However, results are unchanged if we include these.

7. Sensitivity analysis

We now examine the sensibility of our results with respect to certain choices we made about measurements and sample inclusion and show that our results hold to these changes.

Our original sample both includes one- and many-times deployed and a large group of non-deployed eligible men. Given mental health is both sensitive to time and age and to simplify we first focus on one-time deployed and their matched eligible men. However, we need to investigate whether the effects we find are specific to the matched sample or if they can be generalized to the original sample.

To check that the results are not driven by the choice of the imputed deployment year for the eligible men in the comparison group, we also impute these deployment years randomly. In Table 7, Panel A shows the result for the matched sample with random imputed deployment years. The 1.4 percentage point deployment effect in Panel A is not significantly different from the 1.0 percentage point in Table 6 (matched sample with imputed dates). Furthermore, we also estimate the model on a non-matched sample including the one-time deployed soldiers and the full sample of non-deployed eligible men (panel B). In this sample we randomly impute the deployment year for the comparison group consisting of all the eligible men, it gives one percentage point change (see table 7, panel B). Consequently the results appear to hold with other imputation methods. However, the matching method for imputing dates appears more relevant because it relies on appropriate covariates that influence mental health as shown by the literature.

Until now we have excluded the many-time deployed from our estimation sample and Table 2 showed that the one-time deployed had more mental health problems than the many-time deployed after deployment. Although, this finding might be the result of a further DAF selection not allowing the soldiers to be deployed again if they are mentally ill, it can also result from an individual choice. For example, (Glad and Lyk-Jensen, 2013) show that many Danish young men choose to be deployed only once just to have a once-in-a-lifetime experience.

Moreover, the main reason for observing more soldiers with only one deployment among those with a psychiatric diagnosis or purchase of NS-drugs is that the probability of having a medical

record is higher after they have left the army or have stopped being deployed. For the many-time deployed, we may expect a kind of incapacitation effect preventing them for being recorded during the period.

Descriptive statistics on the 26,000 soldiers show that 34 percent (Lyk-Jensen et al., 2012b) of all soldiers recorded with a psychiatric diagnosis (1,400 in total) are recorded more than six years after their last mission (occurring in the period 1992–2009). As we use the first deployment year to divide the pre-and post-deployment periods and most of the one-time deployed were deployed in the beginning of the analysis period, this choice implies that we observe the many-time deployed for fewer years than the one-time deployed (see figure A.3 in the appendix). Excluding many-time deployed only causes a bias if this group is ex ante very different from the one-time deployed. However, table 2 shows that the two groups only differ with regards to AFQT scores (slightly higher for one-time deployed) and that one-time deployed are slightly older (23.3 years vs. 22.8 years). Given the empirical findings about the positive correlation of high IQ and mental health (Macklin et al, 1998), excluding deployed with lower AFQT scores should not increase the effect of deployment on mental health service use. Moreover, the incapacity of many-time deployed to use mental health services, while deployed also contributes to our results being a lower bound. Thus, including the many-time deployed we will expect the effect to be smaller than for only the one-time deployed. The results in Table 7 (panel C) confirm this hypothesis, we find a significant effect of 0.4 percentage point. Thus as expected, this effect is smaller than among the one-time deployed given that the sample mean on mental illness rate is about the same.

The advantage of having a panel data is that we can investigate the deployment effect over time. However, as Bertrand et al. (2004) argued fairly long time series can cause serial correlation and result in inconsistent standard errors. To account for this problem, we collapse our data in one pre-period and one post-period. Table 7, Panel D shows that the deployment effect is significantly 4.7

percentage points which is equal to a 26 percent increase compared to sample mean. This result is not significantly different from the results on the panel data.

As psychiatric diagnosis could be a more precise measure of mental health, compared to the purchase of NS drugs that may be used for different pathologies Table 7 Panel E shows the results for psychiatric diagnosis only. The results are similar if we only use psychiatric diagnosis as health measures. The combined health measure results are more significant, especially because of the increased number of occurrences for mental health in the sample.

Table 7

Sensitivity analysis of the results of the effect of deployment on mental health. Cohorts 1975–1982.

		Average sample mean for mental illness	No of observation
Outcome: Combined mental health measures			
Panel A. One-time deployed and matched eligible men with random dates for deployment			
Deployed*after	0.014*** (0.003)	0.042	85248
Panel B. One-time deployed and full sample of eligible men with random dates for deployment			
Deployed*after	0.009*** (0.002)	0.047	1718480
Panel C. Full sample of deployed (one-time and many-time deployed) and full sample eligible men with random dates for deployment			
Deployed*after	0.004*** (0.002)	0.047	1775392

Panel D. One-time deployed and matched eligible men with matched dates for deployment and two-period (before and after)			
Deployed*after	0.047***	0.179	10656
	(0.014)		
Outcome: psychiatric diagnose			
Panel E. One-time deployed and matched eligible men with random dates for deployment and psychiatric diagnosis as an outcome.			
Deployed*after	0.002**	0.005	85248
	(0.001)		

Standard errors clustered at the individual level in parentheses: * p<10, ** p<0.005, *** p<0.01.

Note: The combined mental health measures include psychiatric diagnosis and purchase of NS-drug. The matched sample includes the 2,664 one-time deployed and the 2,664 matched non-deployed eligible men, while the full sample of eligible men include 104,741 non-deployed and 2,664 one-time deployed and 3,557 many time deployed. Matched date means that within a match pair the deployment year for non-deployed is imputed from the corresponding matched deployed. Random date means that we randomly allocate deployment year for non-deployed eligible men. The controls include a matrix of variables that entered the original matching procedure (i.e., single in AFD year), raised in single-parent family, placed out-of-home care as a child, immigrant, AFD year, year of birth, no. of tasks solved at the AFQT on average. We exclude psychiatric diagnosis up to AFD year to avoid having a lagged dependent variable on the right-hand side of the regression. However, results are unchanged if we include these.

Our findings of the relationship between mental health and deployment are remarkably similar across the different sub-samples. Overall our sensitivity analysis shows that the results in Table 6 are reliable under different assumptions concerning the comparison group of non-deployed eligible men and the measure of mental health. All in all this sensitivity analysis contributes to the external validity of our results

8. Summary and Conclusion

In the substantial literature on soldiers over the past 20 years, no previous studies have investigated pre- and post-deployment mental health for a full population of soldiers as fully as this study does.

Furthermore, our results show that after accounting for the selection bias, deployment on average worsens the mental health of eligible men. We measure mental health as a combination of psychiatric diagnosis and purchase of mental health-related medication. The effects appear more than three years after the last deployment. After making the two groups comparable by correcting for pre-deployment socio-demographic and ability differences, we find that deployment reduces soldiers' mental health and deployment has a long-lasting effect on mental health outcomes. This result holds not only for the matched sample with pairwise matched deployment dates, but also for random deployment dates and the full sample of eligible men. We do not expect an upward bias in records for the soldiers. Indeed, our analysis period (1996–2010) occurs before Denmark implemented a veteran's policy to help soldiers with mental or physical injuries from military deployment (by the end of 2010); therefore, during our analysis period soldiers did not benefit from special attention. To the contrary, we expect the soldiers to be more reluctant to seek help, as doing so may have a negative impact on their military career (see Hoge et al., 2004).

We find that the effect of deployment on soldiers' mental health is significant after 4 years, compared to the comparison groups of eligible men. Thus deployment increases mental health problems by 1 percentage point for the deployed, i.e. a 24 percent increase compared to the sample mean.

Contrary to previous studies, we do not find significant effects for growing up in an unstable social environment or having low AFQT scores on the risk of becoming mentally ill. Only deployed soldiers who had a psychiatric diagnosis before age 18 do have a higher risk for post-deployment mental impairment. Furthermore, we find that soldiers sent to Afghanistan and Balkans have higher risk of becoming mentally ill than soldiers deployed in Iraq or to other missions, which is consistent with the context and level of exposure of these two missions. Denmark first implemented a veteran's policy after 2010 and no changes in the benefits rules occurred during the analysis period.

Soldiers deployed to the Balkans were not prepared to witness such violence without being allowed to intervene and received very little support and help post-deployment, while extreme war conditions for Afghanistan likely explain this result.

Furthermore, our results probably provide the lower bound of the problem. Because we expect the soldiers to be more reluctant to seek help, as doing so may have a negative impact on their military career (see Hoge et al., 2004) and we excluded some soldiers deployed in the 1990s in the Balkans, because we did not have their AFQT.

Given that the effect on mental health may occur some years after the latest deployment, and that soldiers deployed in the beginning of the analysis period have a higher probability of being recorded than soldiers more recently deployed, we can therefore expect even higher incidences of mental illness for former Afghanistan's soldiers in the future.

All in all, our results show an indirect cost of war due to soldiers' higher post-deployment risk of mental health deterioration. Thus when politicians and governments estimate the costs of war, they not only have to take into account the higher risk of mental health deterioration for all deployed soldiers, but also consider the implications of this risk for both soldiers and their families, and the larger societal impact.

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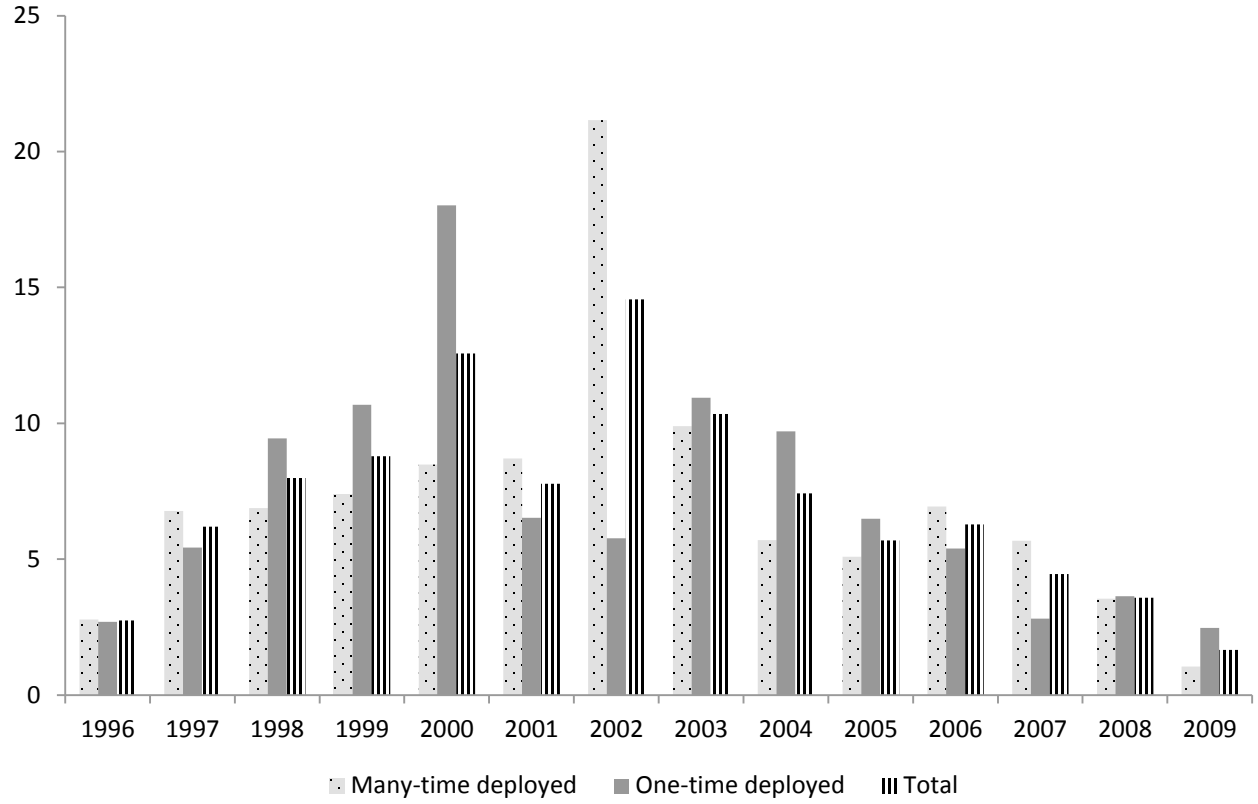
10. Appendix

Figure A.1

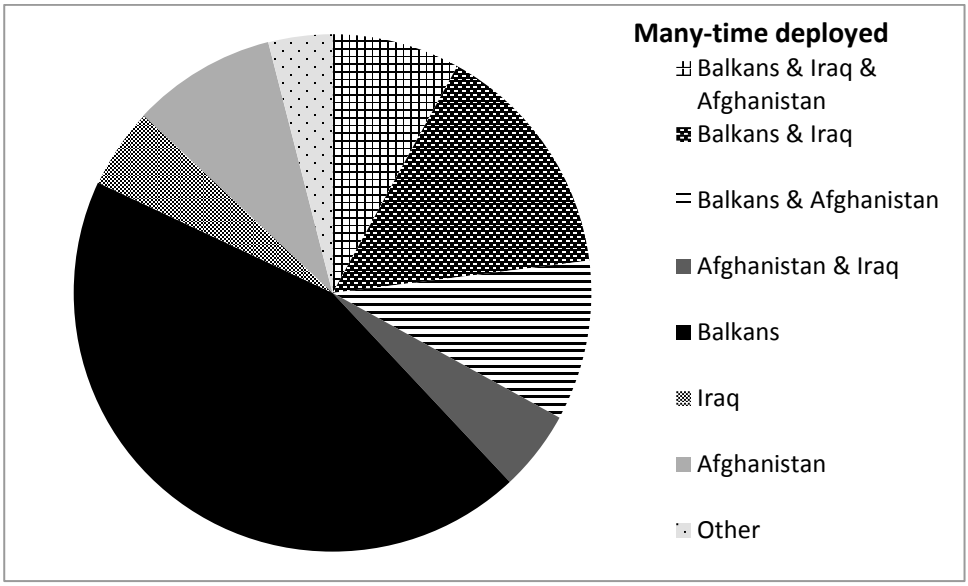
Deployed soldiers by first deployment year and number of deployments (one or many). Deployment period 1996–2009. Percent.



The figure shows the share of the one-time and the many-time deployed measured in the period 1992–2009 and the total by mission year.

Figure A.2

Mission experience for one-time and many-time deployed, born 1975–1982.



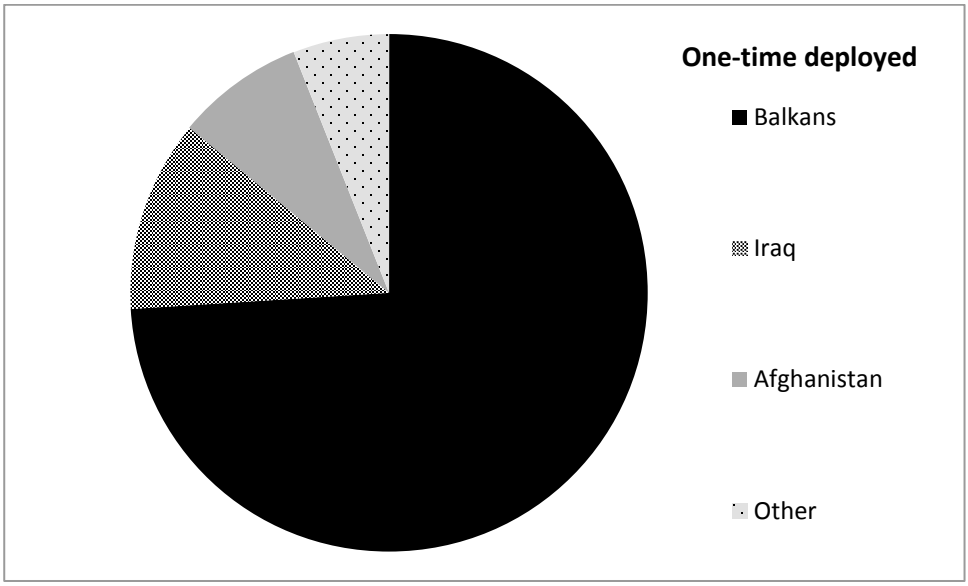


Figure A.3

Number of treated observations before and after the first deployment.

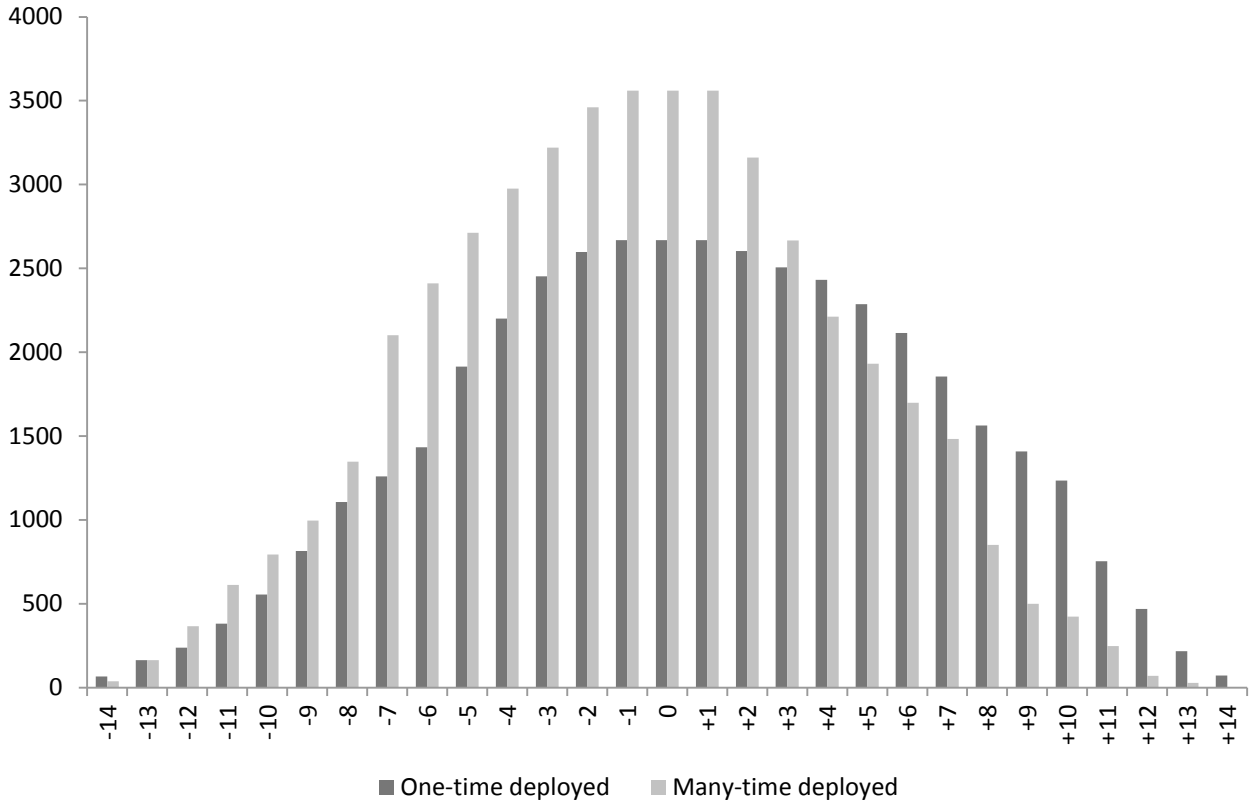
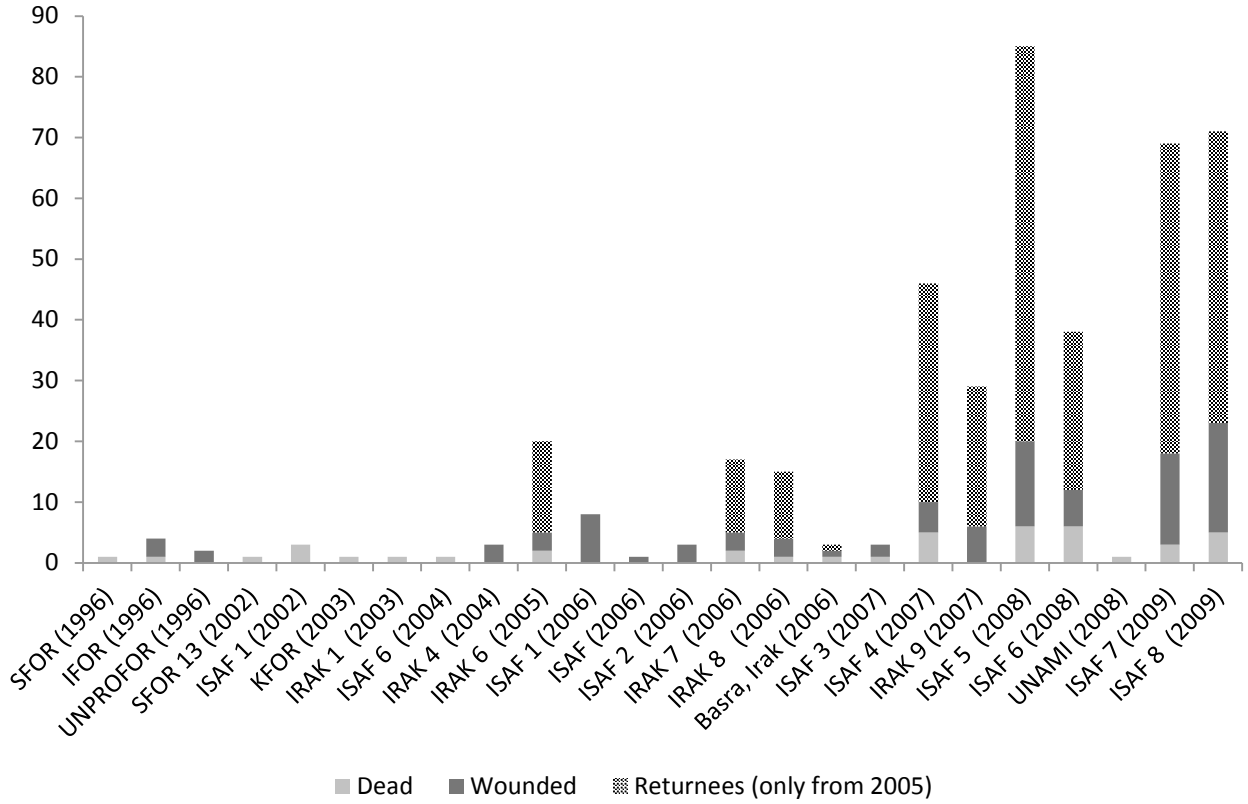


Figure A.4 Number of Danish soldiers, dead, wounded or returnees (1996-2009).



Note: Figure A.4 shows the number of dead, wounded and returnees before the end of the mission (year of the mission in parentheses). Notice that data for returnees is only available from 2005. **SFOR**: Stabilization Force (December 1996 to 2004) in Bosnia-Hercegovina; **IFOR**: UN-Mandated Implementation Force (December 1995, December 1996) in Bosnia-Hercegovina. **UNPROFOR**: United Nations Protection Forces (1992–1995) in Bosnia-Hercegovina, Croatia, Serbia, Montenegro and Macedonia; **ISAF**: International Security Assistance Force (2002–) in Afghanistan. **UNAMI:** United Assistance Mission for Iraq**. IRAK:** Coalition in Iraq.

Table A.1

Number of deployments in the period 1996–2009.

Number of deployments	Freq.	Percent
1	2,664	42.82
2	1,849	29.72
3	866	13.92
4	425	6.83
5	236	3.79
6	111	1.78
7	46	0.74
8	11	0.18
9	10	0.16
>9	3	0.05
Total	6,221	100

Table A.2

The one-time deployed.

AFD year			First deployment year			Age at the first mission		
	Freq.	Percent		Freq.	Percent		Freq.	Percent
1994	156	5.86	1996	72	2.70	19	15	0.56
1995	388	14.56	1997	144	5.41	20	186	6.98
1996	403	15.13	1998	250	9.38	21	509	19.11
1997	359	13.48	1999	285	10.70	22	536	20.12
1998	432	16.22	2000	481	18.06	23	450	16.89
1999	180	6.76	2001	174	6.53	24	323	12.12
2000	216	8.11	2002	154	5.78	25	168	6.31
2001	280	10.51	2003	291	10.92	26	140	5.26
2002	157	5.89	2004	259	9.72	27	101	3.79
2003	51	1.91	2005	172	6.46	28	73	2.74
2004	13	0.49	2006	144	5.41	29	62	2.33
2005	7	0.26	2007	75	2.82	30	45	1.69
2006	15	0.56	2008	97	3.64	31	26	0.98
2007	5	0.19	2009	66	2.48	32	11	0.41
2008	2	0.08	Total	2664	100	33	12	0.45
Total	2,664	100				34	7	0.26
						Total	2,664	100

Note: The table shows summary statistics for the one-time deployed. Furthermore, they are 19.51 years old on average at conscription (median: 19 years) and 23 years old on average at their first mission (median: 23). We have excluded soldiers for whom the conscription year and/or AFQT was missing.

On average there are three years between conscription and first deployment, corresponding to about one year before starting military service and almost two years to be prepared for a deployment.

Table A.3

Propensity score estimation for being deployed.

Raised in single-parent family (ref. not raised in single-parent family)	0.079***
	(0.021)
Placed in out-of-home care as a child (ref. not placed in out-of-home care as a child)	0.029
	(0.042)
Immigrant (ref. Dane)	-0.296***
	(0.061)
AFD year	0.012
	(0.007)
AFQT	0.003***
	(0.001)
Single (ref. not single)	0.016
	(0.158)
Psychiatric measures before AFD (ref. no Psychiatric measures before AFD)	0.076
	(0.103)
Born 1976 (ref. born 1975)	-0.121***
	(0.034)
Born 1977 (ref. born 1975)	-0.103***
	(0.035)
Born 1978 (ref. born 1975)	-0.154***
	(0.038)
Born 1979 (ref. born 1975)	-0.172***
	(0.041)
Born 1980 (ref. born 1975)	-0.286***
	(0.047)
Born 1981 (ref. born 1975)	-0.282***
	(0.053)
Born 1982(ref. born 1975)	-0.186***
	(0.057)
Observations	107.405
Log-likelihood	-12420.704

t-test ***$p<0.01$; **$p<0.05$; *$p<0.1$. Standard errors in parentheses. As men do not necessarily attend the AFD at 18 years, we therefore control for both AFD year and year of birth.