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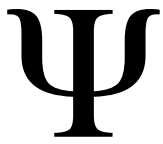

Is there an increase in duration of long-term sickness absence in Norway from 1994 to 2007?
A registry based study

HOVEDOPPGAVE

profesjonsstudiet i psykologi

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Vår 2012

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Bergen, 29th of March 2012

Re: Master thesis of Aleksander Erga and Katrin Hagen submitted spring 2012

Erga and Hagen have, according to the rules at the faculty, written a thesis in a format for submission to the journal BMC Public Health. A Norwegian abstract is included to accommodate the Faculty of Psychology's requirements for master theses. The students have prepared and managed the data, analyzed data, drafted the plan for the paper, and they have written all drafts of the text. They have received supervision on data preparation and management, data analysis, on drafting the story, and on drafts of the paper. Harald Dale-Olsen and Simen Markussen have contributed to discussions regarding the empirical analyses, and Simen Markussen contributed with input to write a formula in the text. After submission as a thesis by April 16, the three supervisors and two other contributors, Harald Dale-Olsen and Simen Markussen, will contribute to further improve the manuscript, and it will be submitted to BMC Public Health within 6 weeks after April 16, and all these will be co-authors on this paper. In conclusion, the manuscript submitted as a thesis by April 16 is a scientific product performed by Hagen and Erga in the role of being students, receiving supervision by three supervisors and two further contributors.

Best regards,

Anja Steinsland	Samuel Harvey	Arnstein Mykletun
Main supervisor	Co-supervisor	Co-supervisor
Stud. PhD, UoB	Senior lecturer, UNSW	Prof II, dr psychol, UoB

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Sammendrag

Bakgrunn: Sykefraværet i Norge er høyt, til tross for bedring i nøkkelindikatorer på folkehelse. Attraksjons- og utstøtingsmodellen tilskriver det høye sykefraværet til henholdsvis valg kontra tvang. Omtrent 80 % av vurderinger av pasienters arbeidsevne er utført av fastleger, og for en fastlege involverer dette en balanse mellom rollen som portvokter og rollen som pasientens advokat. Fastleger rapporterer ubehag i portvokter-rollen, blant annet da vurderinger av pasienters arbeidsevne oppleves som en tvetydig oppgave. Denne vurderingen antas å avhenge av legers-, pasienters- og samfunnets- terskel for å være «syk» og å være «frisk». Vi foreslår at denne terskelen vil kunne være avhengig av endringer i befolkningens holdninger over tid. Målet med denne studien å undersøke om det er en økning i varigheten av langtidssykefraværet i Norge fra 1994 til 2007.

Metode: FD-trygd er et administrativt generert register med longitudinelle forløpsdata på hele den norske befolkningen fra 1992 og utover. Vi testet først en hypotese på fire a-priori utvalgte diagnostiske kategorier, som alle er karakterisert av blant annet en brå og lett observerbar inntreden. Deretter undersøkte vi utviklingen av varigheten av langtidssykefravær i Norge for alle diagnostiske kapitler i ICPC-2.

Resultater: Gjennomsnittlig langtidssykefravær i Norge øker i perioden 1994 til 2007. Resultatene er robuste, og økningen fremtrer i våre utvalgte diagnoser, i majoriteten av alle diagnostiske kapitler i ICPC-2, for begge kjønn, i alle utdanningsgrupper og i de fleste aldersgrupper. Samlet indikerer resultatene at den gjennomsnittlige varighet av sykefravær øker med 1.5 kalenderdager per år i perioden 1994 til 2007. Videre finner vi også en økning i forekomsten av sykefraværsepisoder. Den generelle økningen i sykefraværet kan tilskrives en økning i både varighet- og økning i forekomst av sykefraværsepisoder.

Konklusjon: Den sterke og konsistente økningen i sykefraværsvarighet kan være et resultat av endringer i terskelen for å iverksette og avslutte en sykefraværsepisode. Denne terskelen antas å være avhengig-, og påvirket av, gradvise endringer i befolkningens

holdninger. Vi foreslår at den observerte utviklingen i varighet av sykefraværet påvirkes av en senkning av denne grensen.

Is there an increase in duration of long-term sickness absence in Norway from 1994 to 2007?

A registry based study

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Abstract

Background: Sickness absence in Norway is high despite improvements in key indicators of public health. The pull and the push models attribute the high levels of sickness absence to choice vs. coercion, respectively. Approximately 80% of assessments regarding patients' work ability are performed by GPs, and this involves balancing the role as a gatekeeper with the role as the patients' advocate. GPs report being uncomfortable with this gatekeeping role, partly due to the ambiguousness associated with work ability assessments. These assessments are assumed to be dependent on the threshold for being "sick" or "healthy, whether determined at a GP, patient, or societal level. We suggest that this threshold may be subject to changes in the population's attitudes over time. The aim of this study is to investigate if there is an increase in the duration of long-term sickness absence in Norway from 1994 to 2007.

Methods: FD-insurance is an administratively generated registry, containing longitudinal data on the entire Norwegian population from 1992 and onwards. We first tested a hypothesis on four a-priori selected diagnostic categories from ICPC-2, characterized by an abrupt and overt onset. Secondly, we explored the development of the duration of long-term sickness absence for all ICPC-2 diagnostic chapters.

Results: There is an increase in mean duration of long-term sickness absence from 1994 to 2007. The findings are robust, being observed in our selected diagnoses, the majority of all ICPC-2 diagnostic chapters, for both genders, in all educational groups, and in almost every age group. On average, the duration of sickness absence is prolonged by 1.5 calendar days per year from 1994 to 2007. There is also an increase in prevalence of sickness absence episodes. The general increase in sickness absence can be attributed to an increase in both duration and prevalence of sickness absence episodes.

Conclusion: The strong and consistent increase in duration of sickness absence might be a result of changes in the threshold for initiating and terminating a sickness absence episode. This threshold is presumed to be dependent on, and subject to, gradual changes in attitudes in the population. We suggest that the observed development in duration of sickness absence is affected by an increase in the threshold for terminating a sickness absence episode, and a lowering of the threshold for initiating a sickness absence episode.

Keywords

Sickness absence, sick leave, moral hazard, attitudes, threshold, push, pull, registry data, Norway

Background

High levels of sickness absence in the Norwegian population

Sickness absence levels in Norway are high [1], doubling the average sickness absence levels in the other OECD countries [2]. The cumulative development of sickness absence within Norway has fluctuated during recent decades with a strong increase from mid 1990s to 2001, followed by an abrupt decrease from 2003-2005, and a stabile increase from 2005 and onwards [1, 3]. The sickness absence rates per year is higher for women compared to men [4] and the increasing levels are considered a public health concern, and a challenge with regards to the sustainability of the Norwegian welfare state [5].

Improvements in public health

Parallel to the increase in sickness absence levels, there has been a continuous improvement in the Norwegian population's health [1, 6]. Thus the sickness absence levels have been viewed as a paradox, as the high levels of sickness absence and the inflow to disability benefits, persist in spite of improvements in key indicators in public health [2], such as increased life expectancy, decreased child mortality [7], stabile incidence of mental illnesses [8] and unchanged self reported perception of personal health status [9]. This paradox has led to a strengthening of hypotheses claiming that a potential cause of the high levels of sickness absence might be a change in the population's *attitudes* towards sickness absence [10]. Common mental disorders and musculoskeletal pain compose the main diagnostic categories warranting sickness absence [1, 11-13]. These conditions are highly prevalent in the population, and more often than not, individuals experience these conditions without this resulting in sickness absence [13]. The notion of this in combination with the previously mentioned paradox has led experts to emphasize a distinction between causes of *sickness* and causes of *sickness absence* [13]. Hence, pointing to a discrepancy between *sickness* in a population and *sickness absence* in a population.

The pull and the push models

The pull and the push models offer competing explanations for the high levels of sickness absence. Originating from economical sciences [14] the pull model considers individuals as rational agents, where behavior is directed by consumer incentives and available information [15]. In this view, when facing various courses of action, individuals will be predisposed to make choices that maximize their own benefit [16]. Hence, sickness absence is understood as a result of an individual's rational choices, with these choices being affected by different economic incentives and not simply ill health per se. This phenomenon is called moral hazard [17]. On this note, the pull model argues that absenteeism from work is affected by generosity in welfare programs [18]: the higher the replacement of income during sickness absence, the higher the likelihood of initiating a sickness absence episode [15]. Any transition from employment to sickness benefits is within the understanding of this scope attributed to rational choice [16]. With the welfare state reimbursing 100% of lost income in the case of sickness absence, the pull model would argue that individuals might easily be inclined to choose to stay home with 100% salary instead of receiving the exact same amount of money while at work.

The push model is founded in sociology and social sciences. According to the push model, sickness absence is an involuntary consequence of forces residing outside of an individual's control. Typically, social differences and inequalities [14, 19], like gender differences [19], low socioeconomic status and low education [20] are highlighted as main contributing risk factors to sickness absence. In addition, increased workplace brutality [14, 21], exposure to stress and exceedingly higher demands at an increased number of arenas [14], reduced perception of workplace control [20] and health compromising consequences of labor-market conditions, are suggested as other contributing risk factors to sickness absence. From this perspective, generous levels of sickness benefits could be understood as a

contributor to a more excluding work life, by attracting recipients and forcing them over in more permanent disability benefits [22].

The main difference between the pull and the push model can be summarized into a different weighting of choice vs. coercion, with regards to the processes underlying sickness absence. According to the pull model, effective sickness absence management would be dependent on an increased public control over employees claiming sickness benefits, or a reduced economic compensation trough the Norwegian sickness insurance scheme. If following the rationale from the push model, public initiatives in sickness absence management would focus on reducing any cause of expulsion from the workforce. The Including Workforce Agreement [1], initiated in 2001 is based on the push perspective; by encouraging increased participation and collaboration between GPs, employers and sick listed employees, the Including Workforce Agreement strives to facilitate a speedy return to work for sick listed individuals.

The Norwegian sickness insurance scheme

The Norwegian sickness insurance scheme recompenses 100% of the employees' lost income due to work absence in the event of temporary illness [23] with benefits starting the first day of the sickness absence. The documentation of illness/injury needs certification from a GP when sickness absence exceeds a three-day period. Sickness benefits are issued for a period of one calendar year (365 calendar days = 248 workdays), with the first 16 workdays covered by the employer, and the remaining workdays covered by the Norwegian sickness insurance scheme. No western countries offer such a high degree of compensation. After one calendar year, sickness benefits are terminated, leaving the sick listed individual with a possibility to apply for a transition to more permanent benefits, like disability pension and unemployment benefits. The amount of income being reimbursed is related to the basic amount (B.a.). B.a. is the basic monetary unit used in the pension system, and this amount is

adjusted yearly in accordance with the development of average wages. In 2010 the B.a. was NOK 74 721 [4]. The maximum mandatory reimbursement rate in sickness benefits over a one-year period is 6 B.a. [24].

Policies and interventions for sick listing in Norway have remained mainly unchanged from 1994 to 2007, with the exception being an intervention facilitating use of graded sickness absence (2004), the including workforce program (2001) and a 1998 reform, increasing the number of sick days reimbursed by employers from 14 to 16 days. In 2001 the government also introduced the general practitioner scheme providing all citizens with a permanent general practitioner (GP) through a publicly controlled patient list system [25]. Besides these changes, the major structure of the Norwegian sickness insurance scheme, such as the degree of income compensation and the public management of the sickness insurance scheme, has been unchanged from 1994 to 2007.

The Norwegian primary health care system

The GPs in the general practitioner scheme are self-employed, receiving 30% of their income from a per-capita-based-fee from their patient list, and the remaining 70% from consultation fees reimbursed by patient fees and funding from the Norwegian sickness insurance scheme [25]. Medical consultations regarding sickness certification are frequent [26], and approximately 80% of assessments of a patient's function with regards to work ability are done by GPs in the patient list system [2]. A GPs mandate and responsibility involves balancing the role of advocating the patients' rights in relation to their health related problems and rights to social welfare, as well as effectively restricting public access to welfare benefits, to assure a sustainable functioning of the welfare state [27]. This bipartite role is referred to as "gatekeeping". GPs report being uncomfortable with the gatekeeping role [28, 29], and when forced to choose, GPs more often act in accordance with what they perceive as being in the interest of their patients than in the interest of the society [25, 30].

Studies have indicated that the structural and organizational aspects in the patient list system might have led to a weakening of the GPs gatekeeping as this scheme provides GPs with economic incentives to keep their patients happy, and therefore staying at their patient list [25]. The main reason for the GPs' discomfort in relation to sickness certifications is reported to be frequent conflicts with patients claiming sickness certification without eligible medical reasons [31, 32] and a general difficulty assessing patients' work ability and optimal duration of a sick spell [26, 31, 33].

Sickness absence: Threshold decisions on health continuums

Effective assessment of work ability is affected by the given diagnosis verifiability. "Verifiability" can be defined as "to what extent the medical assessment is based on objective criteria versus on information from the patient" [34]. A study of a representative sample of GPs in Norway, find that the diagnoses that most commonly trigger benefits like musculoskeletal pain and common mental disorders [34, 35], are also among the diagnoses that GPs find least verifiable [34, 35]. These diagnoses are largely based on the patients' subjective symptom descriptions, rather than on more objective medical criteria [34].

Assessing the degree of disability is an ambiguous task whether performed subjectively or by a physician. We suggest that the nature of disability, whether temporary or permanent, cannot be reduced to a healthy-sick dichotomy as almost all health problems and illnesses are located on a continuum ranging from healthy to sick. Although some diagnoses, such as orthopedic fractures, have a clear dichotomous *onset,* both the recovery and the severity of the fracture will vary on a continuum. Following this argument, subjective evaluation of current health status in relation to e.g. illness and work capacity will depend on the physicians' and the patients' threshold for "being healthy" or "being sick". We argue that this threshold may be dependent on and subject to gradual changes in attitudes of the population.

We propose that both the physicians' and the patients' threshold for initiating sickness absence are lower in ambiguous medical assessments with limited access to overt measures of health. Presumably, the threshold for terminating sickness absence is also higher in these cases. However, a previous study reporting on trends in duration for sickness absence, finds that duration of sickness absence for fractures, dislocations and sprains, has increased [10]. These findings might indicate that our concern regarding a decreased and increased threshold for initiating and terminating a sickness absence episode not only arises in relation to ambiguous diagnoses, but also for a wider range of diagnoses.

In sum, sickness absence in Norway is high [1, 2] despite improvements in key indicators of public health. The pull and the push models attribute the high levels of sickness absence to choice vs. coercion, respectively. Approximately 80% of assessments of patients' function with regards to work ability are performed by GPs in the patient list system, and from a GPs perspective this involves balancing the role as a gatekeeper with the role of the patient's advocate. GPs report being uncomfortable with the gatekeeping role, as assessing the degree of work ability is an ambiguous task. This assessment is assumed to be dependent on the threshold for being "sick" or "healthy", whether residing at a GP, patient, or societal level.

The aim of this study is to investigate if there is an increase in the duration of long-term sickness absence in Norway from 1994 to 2007. In this study long-term sickness absence is defined as sickness absence exceeding 16 workdays, hence sickness absence covered by the Norwegian sickness insurance scheme. We hypothesize that the duration of long-term sickness absence has increased over the time period in question. To test this hypothesis, we selected four diagnostic categories a-priori originating from the main diagnostic manual employed by Norwegian physicians and general practitioners: the International Classification of Primary Care, second edition (ICPC-2). Aspiring to avoid potential threshold issues, the

selected diagnoses are characterized by an abrupt and overt onset. Following the hypothesis testing we explored if a similar increase were found in the other ICPC-2 diagnostic chapters.

Methods

Definitions and clarifications

For the purpose of this study the term "sickness absence" refers to 100% sickness absence only, and does not include other variations of sickness absence such as graded- or active sickness absence. We define "duration" as mean duration of long-term sickness absence episodes covered by the Norwegian sickness insurance scheme, thus excluding the initial 16 workdays covered by the employer. We understand "workdays" as 5 days per week, while "calendar days" are defined as 7 days per week. Similarly a work year (248 days) is understood as a calendar year (365 days) minus weekends and official holidays.

Data material

FD-insurance is a historical event database, collected- and prepared for research by the state agencies Statistics Norway, the Norwegian Labor and Welfare Organization and the Department of Taxation. FD-insurance is an administratively generated registry, containing longitudinal data on the entire Norwegian population from 1992 and onwards. The registrations in FD-insurance are at an individual event level, containing high-resolution information on e.g. demographics, social security, employment, income, pension and benefits. Thus, FD-insurance can be combined into event histories providing a lucid overview of transitions in the life of single individuals, the entire population or sub-groups of the population [36]. The registry also includes diagnosis-specific information regarding the cause of individual sick-spells, and has unchanged routines for data- collection and storage during the studied time period. Population documentation of the scale represented in FD-insurance and sensitive data collection over time, is possible due to a high degree of trust between the

Norwegian population and its government. Furthermore, the Norwegian health care system facilitates national data collection due to the publicly controlled management of the general practitioners scheme. The information in FD-insurance is of high quality, but unfortunately due to the registry's complicated structure it is underutilized in research [16]. During the studied time period there is an increase in the populations mean age, percentage of women in the workforce and the percentage of employees with education exceeding high school (Table 1).

Selected diagnoses for testing the hypothesis

The studied diagnoses originate from the main diagnostic manual employed by Norwegian physicians and general practitioners; the International Classification of Primary Care, second edition (ICPC-2) [24]. The ICPC classification system was updated to ICPC-2 in 1998 but the revisions did not affect aspects of relevance for this study. To test our hypothesis, relevant diagnoses were selected based on a-priori criteria. As a prerequisite the selected diagnoses 1) occur with stabile prevalence from 1994 to 2007, 2) have an abrupt onset with a distinct transition from "healthy" to "sick/injured", 3) often require sickness absence longer than 16 workdays, 4) occur in the working population, and finally 5) are not subject to major changes in treatment from 1994 to 2007. Based on these criteria diagnoses affecting different organ systems were selected: fractures, dislocations and sprains; stroke and acute myocardial infarction; appendicitis; and finally, concussion. These diagnoses where further grouped into 1) orthopedic diagnoses, 2) cardiovascular diagnoses, 3) appendicitis, and 4) concussion.

Ideally, our selected diagnoses should not be subject to substantial changes in prevention and treatment procedures, but as it turned out, accommodating this criterion proved more difficult than first anticipated. Treatment or prevention for all selected diagnoses has undergone changes during the period of interest, with advances in both surgical and

pharmacological treatment.

Study population

The target population for this study is full-time employees in the Norwegian population, aged 18 to 67 (Table 1). Our analysis is based on income-information from the working population only, thus excluding information from recipients of e.g. disability benefits. To target full-time employees, people with income below 3.5. B.a. were excluded from the analysis, with the remaining dataset comprising > 50 % of the entire working age population. In 2005, 3.5 B.a. was equivalent to NOK 212,446. In comparison, the 2005 minimum wages for auxiliary nurses were NOK 276,768 per year, while minimum wages for teachers were NOK 340,000 [37]. Employees younger than 18 years, or older than 67 were excluded. Since sickness benefits are terminated after one calendar year, sickness absence exceeding 248 workdays was excluded from the analysis. Individuals with missing data with regards to education or income, and sickness absence episodes with variations in degree, such as graded- or active sickness absence were also excluded. After these exclusion criteria, the remaining dataset describes data on 20,264,582 individuals in total, accumulated in the period 1994 to 2007. In sum, the studied population covers > 50 % of the total Norwegian population aging between 18 and 67.

Data management and analysis

Using STATA/IC 12.0 [38], relevant data was extracted from the FD-insurance datasets with the resulting dataset comprising information about 100% sickness absence for Norwegian full-time employees, aged 18-67. Episodes registered with overlapping dates and diagnoses were merged to ensure correct length of individual sickness absence episodes. Episodes ranging from one year to another, were registered at the year of initiation; e.g. episodes ranging from December 1995 to January 1996, were registered as episodes in 1995. Adjustments were made to accommodate the changes associated with the 1998 reform, where

the number of sick days reimbursed by employers was increased from 14 to 16 workdays. More specifically, we subtracted two workdays from sickness absence records registered after April 1st, 1998. Finally, mean durations of sickness absence were converted from workdays to calendar days, with all results presented in calendar days (365 days per year).

The prevalence for our selected diagnosis groups, as well as total prevalence of all sickness episodes adjusted for population size, was calculated using STATA/IC 12.0. Regression coefficients (β) describing any change in prevalence per year were calculated using SPSS 19. Next, we calculated the mean duration of sickness absence for 1) each of our selected diagnoses, 2) the total sickness absence, as well as for 3) each of the individual diagnostic chapters in ICPC-2. Both prevalence and mean duration was stratified by gender, educational level and age. The stratifications were performed on 1) each of our selected diagnoses, 2) the total sickness absence, as well as for 3) each of the individual diagnostic chapters in ICPC-2. Regression coefficients (β) describing any change in mean duration of sickness absence per calendar year were calculated using SPSS 19. Standard deviations and p-values were considered to be unwarranted, since the analysis is based on the entire full-time work stock of Norway.

To calculate how prevalence, frequency and duration contribute to the increase in sickness absence, we calculated the prevalence of sickness absence episodes per work year. The prevalence was separated into two groups, with duration over and under eight calendar weeks, respectively. The sickness absence rate can be written as the product of the fraction of workers with sickness absence (W), the mean number of sickness absence spells per worker with sickness absence episodes (S) and finally the mean duration of each of these episodes (D). Using the logarithmic approximation of a growth rate $Y_t \Big/ Y_{t-1} - 1 \approx \ln\left(Y_t \Big/ Y_{t-1} \right)$ we decomposed the relative contribution of each of the previously mentioned factors to the total

change in the sickness absence rate. The relative contribution of each of the factors can be written as follows:

$$1 = \frac{\ln\left(\frac{W_{2007}}{W_{1994}}\right)}{\ln\left(\frac{Y_{2007}}{Y_{1994}}\right)} + \frac{\ln\left(\frac{S_{2007}}{S_{1994}}\right)}{\ln\left(\frac{Y_{2007}}{Y_{1994}}\right)} + \frac{\ln\left(\frac{D_{2007}}{D_{1994}}\right)}{\ln\left(\frac{Y_{2007}}{Y_{1994}}\right)}$$

Results

Based on registered sickness absence episodes from 20,264,582 individuals accumulated during the period 1994 to 2007, we found an increase in mean duration of long-term sickness absence. This increase was observed for the a-priori selected diagnostic categories except for cardiovascular diagnoses, and also across all diagnostic chapters in ICPC-2. Overall, sickness absence was prolonged by 1,5 calendar day per year from 1994 to 2007. These results will be described in more detail below.

The prevalence of the a-priori selected diagnoses was stable over the studied time period (Table 2). With "prevalence" we understand the number of registered sickness absence episodes per year, as reported in FD-insurance. When adjusted for size of the studied population, we find that the orthopedic diagnoses, cardiovascular diagnoses, concussion and appendicitis do not have a substantial increase in prevalence. When combining sickness absence episodes from all diagnostic chapters in ICPC-2 and adjusting for population size, there is a 3% yearly increase in prevalence during the studied time period (Table 2).

Testing the hypothesis applying four selected diagnostic categories

There was an increase in duration of sickness absence for the selected diagnoses (Figure 1 and Table 3). The duration of sickness absence for selected orthopedic diagnoses, appendicitis and concussion increased by 1.4, 0.7 and 2.7 calendar days per year, respectively. On the other hand, the duration of sickness absence for selected cardiovascular diagnoses was

almost stabile with a weak negative trend of - 0.1 days per calendar year.

Exploratory analysis across all ICPC-2 diagnostic chapters

The duration of total sickness absence increased by 1.5 calendar days per year from 1994 to 2007 (Table 3). This increase was observed for sickness absence related to most diagnostic chapters in ICPC-2 (Figure 2 and Table 3) except for the chapters N-Neurological and K-Cardiovascular, in which duration of sickness absence had a weak decrease or stagnated, respectively. It is important to note that the ICPC-2 chapter K-Cardiovascular, is comprised of 41 different symptoms, infections, neoplasms, injuries and congenital anomalies, and should not be misinterpreted as the two diagnoses comprising the selected cardiovascular diagnoses.

Analyses of robustness of findings: Stratifications for gender, education and age

The increase in duration of sickness absence for our selected diagnoses was slightly higher for women compared to men (Table 3). However, the increase in duration of sickness absence was slightly higher for men compared to women when combining sickness absence episodes from all diagnostic chapters in ICPC-2. The gender difference in duration of sickness absence varies to a large extent between the different diagnostic chapters in ICPC-2.

The increase in duration of sickness absence could not be attributed to one educational stratum especially (Table 3). The strongest increase in duration of sickness absence was found in the group with education similar to elementary school, with a yearly increase of 1.9 calendar days. Similarly, the increase in duration of sickness absence for individuals with education equivalent to high school, or education exceeding Bachelor's degree increased with 1.7 and 1.3 calendar days, respectively. With two exceptions, the highest increase in duration of sickness absence was found in the group with education similar to elementary school. These findings were consistent across all ICPC-2 diagnostic chapters, and for the selected

diagnoses.

The increase in duration of sickness absence could not be attributed to any particular age group (Table 3). The lowest increase in duration of sickness absence was found in the two oldest age groups, and in the oldest age group (> 59) the duration of sickness absence decreased by approximately one calendar day per year. These findings were observed in all ICPC-2 diagnostic chapters, and for the selected diagnoses.

In sum, the increase in duration of sickness absence was robust when stratified for gender, educational level and age. The increase in duration of sickness absence was most prominent for 1) men, 2) individuals with lower levels of education and 3) individuals younger than 50 years.

What contributes to the general levels of sickness absence in Norway from 1994 to 2007?

Besides the increase in duration of sickness absence, there was also an increase in prevalence of sickness episodes per work year. The prevalence increased for 1) sickness absence episodes with duration over 8 calendar weeks, and for 2) sickness absence episodes with duration less than 8 calendar weeks (Figure 3). The increase in prevalence of sickness absence episodes contributed 64.4 % to the development of total sickness absence over the course of the study, while the increase in duration contributed 32.8 % to the increase. The increase in frequency of sickness absence episodes for the same individual contributed 2.8 % to the increase.

Discussion

Key findings

There was an increase in duration of long-term sickness absence from 1994 to 2007, in which mean duration of sickness absence episodes increased by 1.5 calendar days per year

during the period of interest. This increase was observed in our selected diagnoses and in the majority of all ICPC-2 diagnostic chapters. The increase in duration of sickness absence is observed for both genders, in all educational groups and in all age groups younger than 60 years. Moreover, there was also an increase in prevalence of sickness absence episodes with duration both over and under eight weeks. The general increase in sickness absence could be attributed to an increase in both duration of sickness absence episodes and prevalence of sickness absence episodes.

To the best of our knowledge, there has only been one previous study addressing the duration of sickness absence in Norway for a prolonged period of time similar to the time span in our study [10]. However, this Norwegian study included only orthopedic diagnoses and was based on a dataset with a lower data resolution compared to the data in FD-insurance. Their analyses were based on numbers extracted from the Labor Force Survey, the sickness benefit registry and the employee/employer registry. These are independent and unrelated sources of information, and in comparison, the data in FD-insurance are more elaborately processed.

The majority of studies regarding sickness absence in the Norwegian population have traditionally focused on the aggregated number of compensated days in relation to sickness absence. Hence, our study offers a complementary perspective to the existing literature on sickness absence, by addressing the development of *duration* of long-term sickness absence in the Norwegian population. The vast majority of previous studies have focused on diagnoses that most frequently trigger sickness benefits, such as common mental disorders and musculoskeletal disorders. Our study has focused on all ICPC-2 diagnostic chapters, as well as on a group of physically overt diagnoses. By choosing diagnoses where one could expect a stabile or reduced duration of sickness absence, as in the case with our selected diagnoses, we aimed to access the potential implications of changes in thresholds for initiating, or continuing

a sickness absence episode. The robust increase in duration of sickness absence might be interpreted as a result of a possible increase in the threshold for terminating a sickness absence episode. Similarly the increase in prevalence of sickness absence episodes might reflect a lowered threshold for initiating sickness absence.

Strengths and limitations

The use of the FD-insurance registry is a major strength of this study. It contains diagnosis-specific information regarding the cause of individual sick-spells. Further, the routines for data- collection and storage are unchanged during the period of interest. Another apparent strength of FD-insurance is that it contains registrations of the total population in Norway. This allows us to bypass some of the classic challenges associated with survey-based research such as concerns in relation to attrition, generalizability, response rate, and social desirability. However, a possible limitation with FD-insurance is that the results rely on the accuracy of the registered diagnoses, which may be prone to errors.

Since the aim of this study is to investigate the development of duration of sickness absence for *full-time employees* in the Norwegian population, individuals with income less than 3.5 B.a. were excluded. Due to this selection, it is not possible to generalize our results to part-time employees or employees earning less than 3.5 B.a.. A manifestation of this selection bias might be loss of information regarding the female work stock that more often work part-time and loss of information regarding people employed in low-pay professions. It is also possible that we might have included well-paid part-time employees in our analysis. However, when targeting people earning more than 3.5 B.a., we capture more than 50 % of the Norwegian work stock, limiting the risk of a selection bias. A concern regarding such potential bias is reduced by our observation that when stratifying for age, gender and education, our results still indicate a robust increase in duration of sickness absence.

We hypothesized that our selected diagnoses occur with a stabile prevalence in the Norwegian population from 1994 to 2007. While we were not able to find reliable medical sources on the given prevalence for our selected diagnoses in Norway over the time period in question, based on our dataset we are able to infer that the prevalence of sickness absence episodes due to our selected diagnoses, are fairly stabile (Table 2). However, the cardiovascular group had a 4% increase in prevalence per calendar year. This increase in prevalence of cardiovascular related sickness absence might be a result of the national efforts in diagnosing and preventing cardiovascular incidences. However, we suggest that the increase in prevalence for the cardiovascular group might inoculate against a selection of more grave cases, as would be the case with a potential *decrease* in prevalence.

It proved difficult to select diagnoses unaffected by advances in medical treatment procedures. Nevertheless, we suggest that potential medical advances should facilitate a reduction in the duration of sickness absence, hence contributing to the null-hypothesis, and strengthen rather than weaken our results. However, there is a risk that the medical advances have a paradoxical effect on the duration of sickness absence, by increasing the need for a prolonged recuperation period following more advanced medical procedures. The highest probability for confounding variables arises with regards to our selected diagnoses, where both the selected cardiovascular diagnoses [39] and appendicitis are subject to advances in surgical procedures. In addition, we also presume that the selected cardiovascular diagnoses are subject to advances in pharmacological treatment. We do not expect drastic improvement in treatment and prevention of the selected orthopedic diagnoses or concussion. However, the general increase in duration is observed for all ICPC-2 diagnostic chapters, limiting the risk of confounding variables.

When selecting our diagnoses, they should typically be characterized by an abrupt onset, with a clear distinction between the time as “healthy” and “sick/injured”. Few ICPC-2

diagnoses fulfilled this criterion and the diagnoses that did (our selected diagnoses) still varied with regards to severity. However, the heterogeneity in severity is expected to remain the same during the studied period of time.

Potential causes for the increase in duration of sickness absence

During the studied period of time there is an increase in the populations mean age, percentage of women in the workforce and the percentage of employees with education exceeding high school (Table 1). As opposed to previous studies, our findings do not support the general trend where women drive the observed increases in sickness absence. On the contrary, we find that the increase in duration of sickness absence is more prominent for men compared to women. We find no plausible explanation for this finding.

The increase in duration of sickness absence is highest in the group with education equivalent to elementary school. This finding could be explained by a potential overrepresentation of occupations with physical strain within this group, reflecting that prolonged sickness absence is increasingly necessary in physical occupations compared to academic occupations. However, the increase in employees with high education should outweigh the increase in duration of sickness absence caused by the low education group.

The increase in duration of sickness absence observed in the low educational group could also be attributed to increased immigration during the period of interest, where segments of immigrant groups have lower education and higher levels of sickness absence compared to the mean population. However, these segments of immigrants compose a minority of the employed population in Norway [1], weakening this groups potential impact on the results.

The increase in duration of sickness absence could be explained by an increase in the proportion of aging employees, and weakening of this cohort's health or stamina. However,

the increase in duration of sickness absence is most prominent in the younger cohorts, compared to the cohorts aged > 49. In the group aged > 59, sickness absence decreases.

Another explanation for the general increase in duration of sickness absence is based on a medical perspective. From this point of view, the observed development could be explained as a result of the populations' ill health alone. It is possible, though not plausible, that the increase in duration of sickness absence is a reflection of a deterioration of public health in the Norwegian population, making prolonged sickness absence necessary. However, such an explanation is weakened by studies finding that the prevalence of e.g. musculoskeletal disorders remain stabile over time, while the sickness absence for these disorders increases during the same period of time [9, 40].

Obviously, GPs play a crucial role in affecting the duration of sickness absence. As previously mentioned, the increase in duration of sickness absence, might be caused by a weakening of GPs gatekeeping role after the increased economical incentives following the implementation of the general practitioners scheme in 2001. However, the rise in duration of sickness absence is evident before the implementation of the general practitioners scheme, suggesting that this scheme is not the major driver of the observed development. Another explanation for the increase in duration of sickness absence might be increased difficulties for GPs when determining the optimal duration for a sickness absence episode. The previously mentioned public interventions in sickness absence management are presumed to affect not only the levels of sickness absence, but also the duration of sickness absence episodes. More specifically, the introduction of graded sickness absence in 2004 is assumed to drastically change the sick listing practices among GPs, reducing both the total prevalence of sickness absence and the duration of a sickness absence episode, highlighting the impact of GPs gatekeeping role [41].

Another plausible explanation for the increase in duration of sickness absence, is related to trajectories in the Norwegian society. During the studied period there is a general increase in the percentage of employees in full-time employment in the studied population (Table 1). This increase coincides with the general decrease in unemployment in the general population. This expansion of the work stock might contribute to a ceiling effect, where the additive increase in the employed population leads to a potential inclusion of employees with ill health: employees that under different circumstances e.g. recession periods might not remain in paid work. However, disability rates have increased during the studied time period, indicating that individuals with marginalized health and low work ability are still recruited to more permanent disability benefits. Another hypothesis is that an increased need for employees leads to an associated increase in the employers' demands of work efficiency and tempo. Combined, this might lead to increased work strain, and thus, expanding the risk for sickness absence of longer durations.

The development in duration of sickness absence might also be understood as a result of factors residing outside of the sick listed individual. The increase in duration of sickness absence might be caused by an increasing imbalance between perceived control over perceived demands in different arenas of life. There might be changes in the employer's preferences during the studied time period. With regards to a hypothesis where increased production and efficiency is valued at the workspace, it is possible that employees are urged to stay away from work when sick or disabled. Other circumstantial factors might also have changed, potentially making it increasingly more difficult to attend work with reduced work capacity during the studied period. The stabile prevalence of sickness absence, and the increase in duration of sickness absence might also be a result of increased workplace brutality, where work environments have grown more pathogenic or subject employees to

more physical or mental strain in 2007 compared with 1994. However, today there exists little support for this hypothesis [1].

The increase in duration of sickness absence might also be due to a gradually increasing and expanding moral hazard, where sickness absence is understood as a result of an individual's rational choices and not simply ill health per se. In 2004 "graded sickness absence" was implemented to hamper the expanding growth in sickness absence levels. This public reform resulted in an evident reduction in duration of sickness absence, as illustrated in Figure 2. This public responsiveness to changes in public policy might be interpreted as a demonstration that levels of sickness absence and duration of sickness absence do not reflect the population's ill health. However, if only emphasizing this point of view, one might fail to incorporate the fact that individuals might actually be sick, and sickness absence after a very serious illness or injury can hardly be argued to be a voluntary, rational choice.

The residual explanation, -threshold issues and attitudes.

We suggest that the results might indicate an attitudinal change with regards to the threshold for initiating and terminating a sickness absence episode. We initially presumed that this threshold was more dependent on personal attitudes when initiating sickness absence due to *diffuse* diagnoses, and less dependent on personal attitudes when initiating sickness absence due to *overt* diagnoses, similar to our selected diagnoses. Prior to our analysis we also assumed that attitudes play a fairly similar role when determining the appropriate threshold for terminating a sickness absence episode, for both *diffuse* and *overt* diagnoses. However, the increase in duration of sickness absence is observed for all diagnostic chapters in ICPC-2, and this does not provide support for our differentiation of the role of attitudes in sick listing practices for diffuse and overt diagnoses.

The nature of our study design precludes our results from providing detailed explanations for the processes underlying the initiation of a given sick spell episode.

However, our results do provide indirect support of our hypothesis that the increase in duration of sickness absence and in the prevalence of sickness absence, might be affected by 1) an increase in the threshold for terminating a sickness absence episode, and 2) a lowering of the threshold for initiating a sickness absence episode, respectively. If the increase in duration and prevalence of sickness absence is attributable to a change in the threshold for terminating and initiating a sickness absence episode, this change might originate at GPs, in the general society or at an individual level.

Implications

Long-term sickness absence increased by 1.5 calendar days per year from 1994 to 2007. This increase is substantial, and if this development remains unaltered, the sustainability of the Norwegian welfare state might be jeopardized. At a societal level the increased public expenses are persuasive. From 1994 to 2004 public expenses in relation to sickness absence increased from NOK 10.442 billion to NOK 26.869 billion [35]. Hence the population's sickness absence greatly affects the direction of public funding, in addition to the consequences associated with decreased individual contribution to the work stock [1]. Employers also suffer economic costs, either through the mandatory monetary expenses during the 16 days employer period, by expenses associated with hiring temporary employees, or through production loss [1, 17]. At a personal level, sickness absence has a wide range of implications on individual health, social life, lifestyle and emotional wellbeing [42]. Sickness absence is associated with decreased life quality, loss of social participation and loss of identity [1]. Sickness absence exceeding 8 calendar weeks greatly increases future risk of becoming recipients of more permanent disability pensions or being excluded from the workforce [1]. However, even after return to work, previous sickness absence increases the risk of decreased income [43] and reduced career possibilities [44]. Today there exists a robust empirical load and a strong scientific consensus that work is beneficial for both mental

and physical health [1, 45], and this has led to national efforts in reducing the high levels of sickness absence. On this note, national experts have highlighted a number of myths associated with sickness absence [1], myths that we presume might influence the population's threshold with regards to initiation and termination of sickness absence episodes. By disproving typical misconceptions like "One has to be 100% healthy to be able to work" and "Work is bad for your health if you are ill" experts hope to affect peoples' attitudes by elevating the public threshold for initiating and maintaining sickness absence.

Conclusion

We found a strong and consistent increase in duration of sickness absence of 1.5 calendar days per calendar year from 1994 to 2007. Multiple causes have been suggested with a varying degree of support; some of the less plausible explanations attribute the increase in duration of sickness absence to changes in 1) demographics in the population, 2) health status in the population or 3) increased brutality in work environment. However, we find little support for these explanations.

Plausible causes to the increase of the duration of sickness absence in the period might be 1) a weakening in gatekeeping among GPs, 2) an increase in moral hazard in the population and 3) changes in attitudes towards sickness absence. More specifically, we suggest that the increase in duration of sickness absence might be a result of 4) changes in the threshold for initiating and terminating a sickness absence episode. Further, this threshold is presumed to be dependent on, and subject to, gradual changes in attitudes in the population. We suggest that the observed development in duration of sickness absence is affected by an increase in the threshold for terminating a sickness absence episode, and a lowering of the threshold for initiating a sickness absence episode.

List of abbreviations

GP: General Practitioner

B.a.: Basic Amount

ICPC-2: International Classification of Primary Care second edition

Competing interests

The authors declare that they have no competing interests'.

Authors' contributions

KH and AHE contributed equally during all stages of this study; planning the study design, data management, data analysis, and preparation and completion of the manuscript. AS supervised during planning of the study and during the initial phases of data management and analysis. AM supervised during preparation of the manuscript, and interpretation of results. SH supervised during planning of the study design and preparation of the manuscript.

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Table 1 - Characteristics of the studied population and the Norwegian population

Year	Mean age*	Percentage of women in the workforce*	Percentage with education equivalent to Bachelor's degree or higher*	Percentage of population in fulltime employment *	Total population of Norway**	Percentage of unemployment in the Norwegian population**
1994	39.3	39.6 %	30.0 %	28.0 %	4 324 815	5.20 %
1995	39.5	39.7 %	30.0 %	29.1 %	4 348 410	4.70 %
1996	39.8	39.9 %	31.0 %	30.1 %	4 369 957	4.20 %
1997	40.0	40.1 %	32.0 %	31.2 %	4 392 714	3.30 %
1998	40.2	40.4 %	32.0 %	32.4 %	4 417 599	2.40 %
1999	40.5	40.9 %	33.0 %	33.1 %	4 445 329	2.60 %
2000	40.9	41.2 %	33.0 %	33.3 %	4 478 497	2.70 %
2001	41.2	41.5 %	34.0 %	33.5 %	4 503 436	2.70 %
2002	41.6	41.9 %	35.0 %	33.5 %	4 524 066	3.20 %
2003	42.0	42.2 %	36.0 %	33.0 %	4 552 252	3.90 %
2004	42.4	42.3 %	37.0 %	32.6 %	4 577 457	3.90 %
2005	42.7	42.4 %	38.0 %	32.8 %	4 606 363	3.50 %
2006	42.8	42.7 %	38.0 %	33.7 %	4 640 219	2.60 %
2007	42.9	42.9 %	39.0 %	34.5 %	4 681 134	1.90 %

Footnotes:
* Based on the studied population
** Source: Statistics Norway

Table 2 - Crude and population adjusted* prevalence of selected diagnoses and for all ICPC-2 diagnoses

Year	Prevalence type	Selected orthopedic diagnoses	Selected cardiovascular diagnoses	Appendicitis	Concussion	All ICPC-2 diagnoses
1994	Crude	10 987	1 012	494	365	158 584
	*Adjusted**	*10 987*	*1 012*	*494*	*365*	*158 584*
1995	Crude	12 713	1 151	569	477	181 012
	*Adjusted**	*12 168*	*1 102*	*545*	*457*	*173 249*
1996	Crude	13 815	1 255	577	530	204 821
	*Adjusted**	*12 692*	*1 153*	*530*	*487*	*188 165*
1997	Crude	15 293	1 361	655	562	229 722
	*Adjusted**	*13 482*	*1 200*	*577*	*495*	*202 521*
1998	Crude	16 415	1 507	713	536	257 362
	*Adjusted**	*13 870*	*1 273*	*602*	*453*	*217 465*
1999	Crude	16 249	1 506	611	536	288 633
	*Adjusted**	*13 355*	*1 238*	*502*	*441*	*237 232*
2000	Crude	17 657	1 716	626	596	321 934
	*Adjusted**	*14 335*	*1 393*	*508*	*484*	*261 368*
2001	Crude	17 935	1 746	659	584	335 053
	*Adjusted**	*14 364*	*1 398*	*528*	*468*	*268 339*
2002	Crude	17 986	1 865	628	563	343 310
	*Adjusted**	*14 350*	*1 488*	*501*	*449*	*273 914*
2003	Crude	16 499	1 957	600	540	346 900
	*Adjusted**	*13 307*	*1 578*	*484*	*436*	*279 778*
2004	Crude	15 491	1 825	548	541	308 380
	*Adjusted**	*12 549*	*1 478*	*444*	*438*	*249 804*
2005	Crude	15 279	1 990	540	597	319 089
	*Adjusted**	*12 237*	*1 594*	*432*	*478*	*255 559*
2006	Crude	15 934	2 072	495	662	333 141
	*Adjusted**	*12 335*	*1 604*	*383*	*512*	*257 894*
2007	Crude	16 159	2 012	531	712	345 590
	*Adjusted**	*12 106*	*1 507*	*398*	*533*	*258 917*
Calculated β^{Γ}	Crude	271	80	-4	16	13 865
	*Adjusted**	*13*	*44*	*-12*	*5*	*7 915*

Footnote:

* = Prevalence adjusted to size of the studied population in 1994.

Γ = Linear regression coefficient

Independent variable: Years

Dependent variable: Prevalence

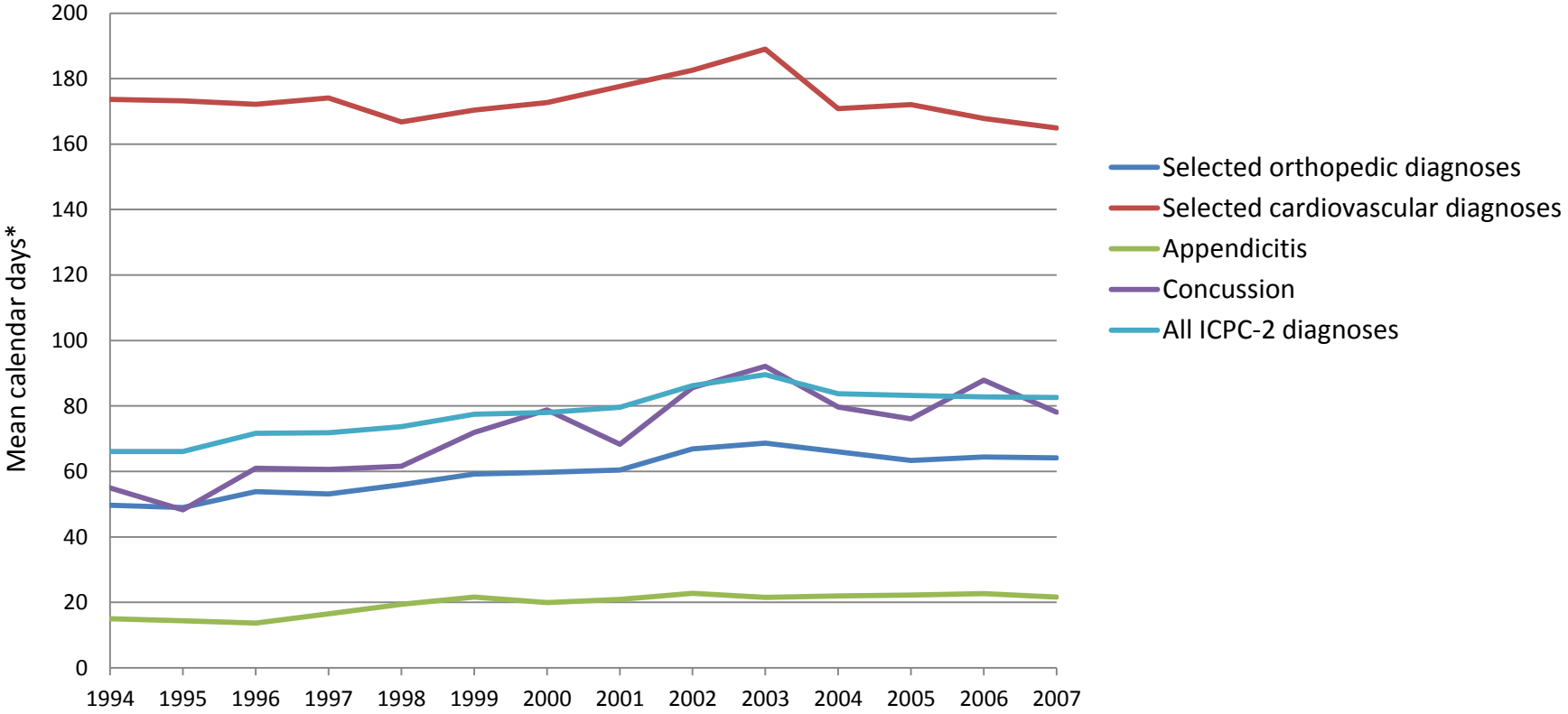
β = increase in prevalence per year

Table 3 - Increase (β)* in duration of long-term sickness absence from 1994 to 2007, unstratified and stratified for gender, education and age

Diagnoses	Number of sickness absence episodes in 2007	Mean duration of sickness absence in 2007	Unstratified (β)*	Men (β)*	Women (β)*	Elementary school (β)*	High School (β)*	Bachelor's degree or higher (β)*	18-29 (β)*	30-39 (β)*	40-49 (β)*	50-59 (β)*	>59 (β)*
Selected orthopedic diagnoses	16 159	64.1	1.4	1.2	1.5	1.7	1.5	1.0	1.0	1.2	1.2	1.2	0.5
Selected cardiovascular diagnoses	2 012	165.0	-0.1	-0.3	0.3	0.7	0.3	-0.7	-3.7	0.3	0.2	-0.4	-2.3
Appendicitis	531	21.6	0.7	0.6	0.8	1.0	0.5	0.7	0.3	0.4	0.9	0.8	0.9
Concussion	712	78.1	2.6	2.5	2.6	3.5	2.1	2.0	1.5	2.9	2.0	2.7	5.1
All ICPC-2 diagnoses	345 590	82.6	1.5	1.7	1.4	1.9	1.7	1.3	1.3	1.5	1.3	1.1	-0.8
A General and Unspecified	20 036	74.1	2.6	2.7	2.6	2.8	2.7	2.6	2.1	2.5	2.7	2.3	1.0
B Blood**	1 534	121.8	1.8	1.4	2.0	2.2	1.8	1.7	0.6	0.6	1.0	2.1	-0.1
D Digestive	16 071	64.3	1.3	1.5	1.0	1.4	1.2	1.6	0.9	1.0	1.2	1.1	0.4
F Eye	2 513	60.3	0.8	1.1	0.5	1.0	0.9	0.8	0.7	0.8	0.2	0.8	-0.1
H Ear	2 620	80.2	2.0	2.2	1.9	2.4	1.4	1.8	0.4	1.8	1.3	1.1	1.1
K Cardiovascular	15 312	104.2	0.1	0.0	0.8	0.6	-0.1	0.6	0.6	0.7	-0.1	-0.7	-3.2
L Musculosceletal	141 323	85.3	1.7	1.8	1.4	2.1	1.9	1.1	1.3	1.7	1.5	1.2	-0.7
N Neurological	16 353	91.0	-0.1	-0.2	0.1	0.2	0.2	-0.5	0.4	0.4	-0.5	-1.0	-3.4
P Psychological	60 006	98.6	1.4	1.2	1.5	1.9	1.3	1.1	1.3	1.4	1.3	1.1	-1.1
R Respiratory	22 693	40.8	1.0	1.1	1.0	1.3	1.0	1.2	0.4	0.9	0.8	0.9	-0.1
S Skin	7 895	55.8	1.0	1.1	0.8	1.3	0.9	1.1	0.8	1.2	0.9	1.1	-0.2
T Endocrine***	5 752	92.8	0.6	1.0	0.4	1.0	0.1	0.9	0.7	0.0	0.4	0.6	-2.0
U Urological	2 488	65.8	0.9	1.9	0.1	1.2	0.8	0.8	1.1	1.1	0.5	0.5	-1.0
W Pregnancy****	23 157	73.4	1.2	1.9	1.1	1.9	1.6	1.1	1.3	1.1	1.3	1.8	5.3
X Female, genital	6 134	86.8	1.6	-	1.6	1.8	1.3	1.9	0.8	0.8	1.0	1.6	0.2
Y Male Genital	1 518	80.0	2.2	1.6	-	3.0	1.7	1.7	2.0	1.1	1.0	2.4	0.9
Z Social Problems	69	80.4	3.9	4.2	3.8	4.0	2.4	4.4	2.3	3.0	4.3	5.0	3.3

Footnotes:
* Dependent variable: Years
Independent variable: Mean duration of sickness absence episodes
β = Increased calendar days per calendar year
** Chapter B Blood, Blood Forming Organs and Immune Mechanisms
*** Chapter T Endocrine/Metabolic and Nutritional
**** Chapter W Pregnancy, Child Bearing, Family Planning

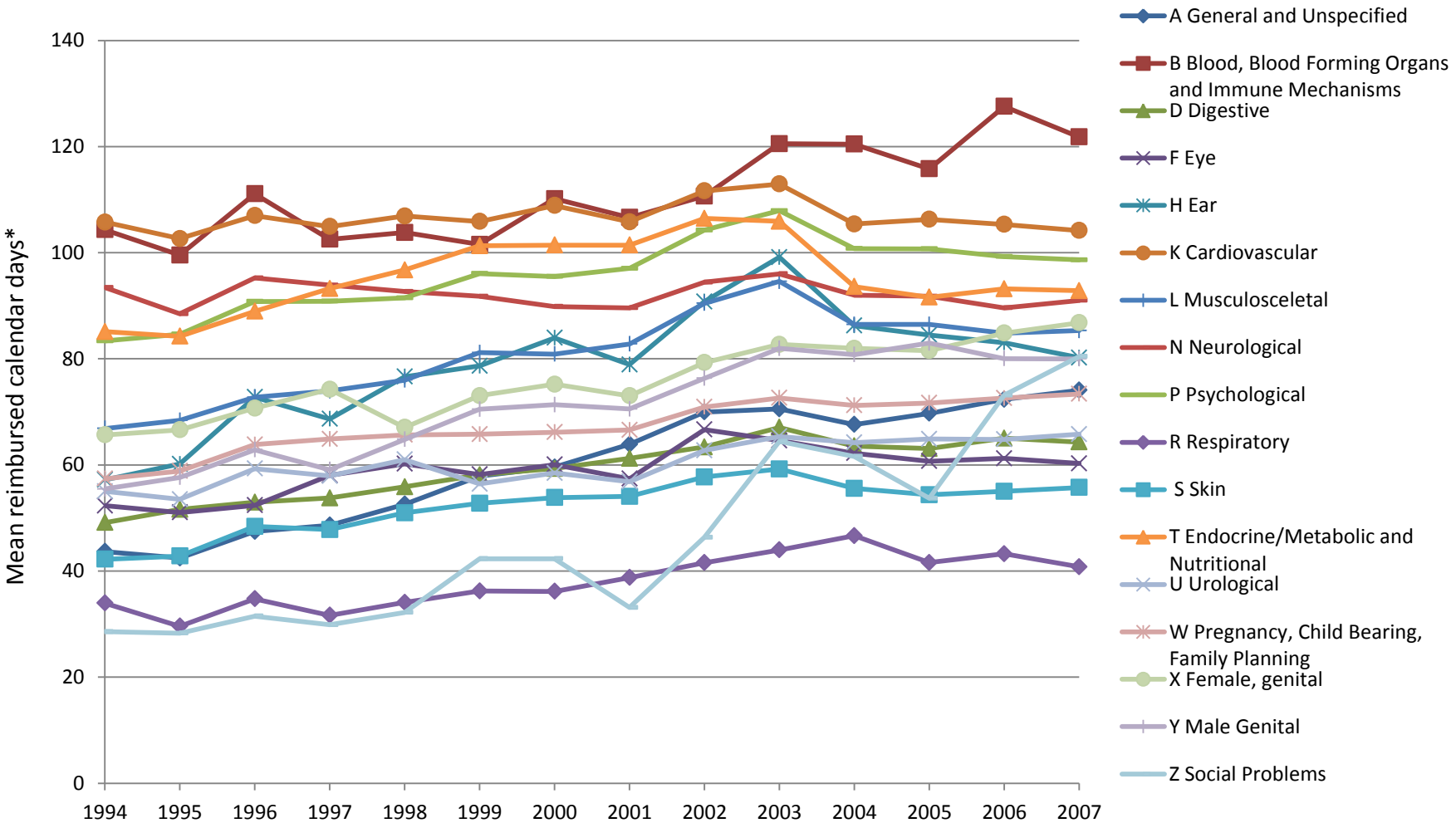
Figure 1 - Duration of sickness absence* for selected diagnoses and all ICPC-2 diagnoses



Footnote:

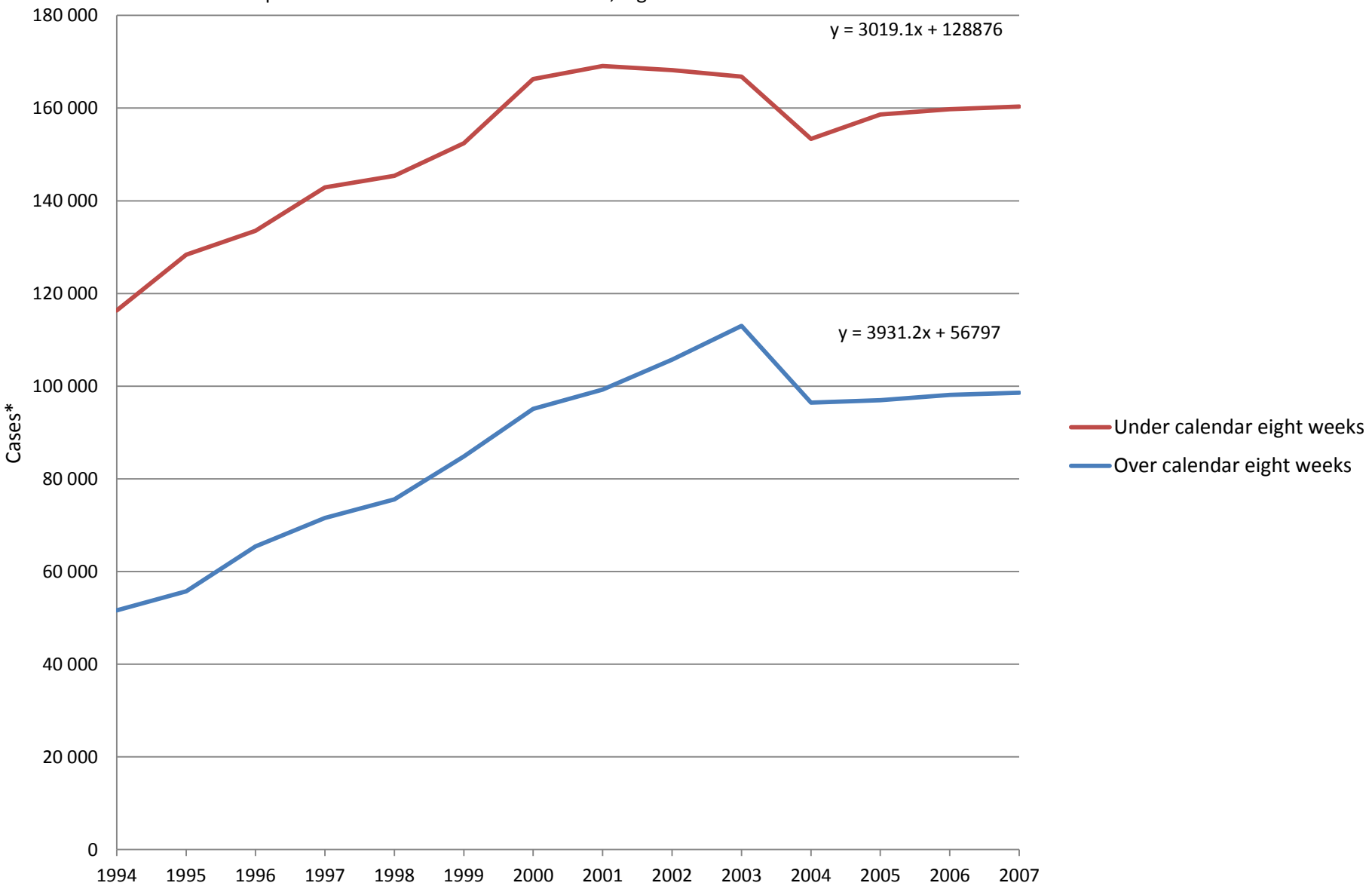
* Sickness absence exceeding 16 days, hence reimbursed by the National Sickness Insurance Scheme

Figure 2 - Mean duration of sickness absence* for all ICPC-2 diagnostic chapters



Footnote:
* Sickness absence exceeding 16 days, hence reimbursed by the National Sickness Insurance Scheme

Figure 3 - Development of prevalence* of sickness absence episodes per calendar year, divided into sickness absence episodes with duration over and under-, eight calendar weeks



Footnote:
* Adjusted for population size

Appendix I:

BMC Public Health Instructions For Authors

Instructions for authors

Research article

Criteria | Submission process | Preparing main manuscript text | Preparing illustrations and figures | Preparing tables | Preparing additional files | Style and language

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During submission you will be asked to provide a cover letter. Use this to explain why your manuscript should be published in the journal, to elaborate on any issues relating to our editorial

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Manuscripts for Research article articles submitted to *BMC Public Health* should be divided into the following sections (in this order):

- Title page

- Abstract
- Keywords
- Background
- Methods
- Results and discussion
- Conclusions
- List of abbreviations used (if any)
- Competing interests
- Authors' contributions
- Authors' information
- Acknowledgements
- Endnotes
- References
- Illustrations and figures (if any)
- Tables and captions
- Preparing additional files

The **Accession Numbers** of any nucleic acid sequences, protein sequences or atomic coordinates cited in the manuscript should be provided, in square brackets and include the corresponding database name; for example, [EMBL:AB026295, EMBL:AC137000, DDBJ:AE000812, GenBank:U49845, PDB:1BFM, Swiss-Prot:Q96KQ7, PIR:S66116].

The databases for which we can provide direct links are: EMBL Nucleotide Sequence Database (EMBL), DNA Data Bank of Japan (DDBJ), GenBank at the NCBI (GenBank), Protein Data Bank (PDB), Protein Information Resource (PIR) and the Swiss-Prot Protein Database (Swiss-Prot).

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Please note:

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The Abstract of the manuscript should not exceed 350 words and must be structured into separate sections: **Background**, the context and purpose of the study; **Methods**, how the study was performed and statistical tests used; **Results**, the main findings; **Conclusions**, brief summary and potential implications. Please minimize the use of abbreviations and do not cite references in the abstract. **Trial registration**, if your Research article articles reports the results of a controlled health care intervention, please list your trial registry, along with the unique identifying number (e.g. **Trial registration**: Current Controlled Trials ISRCTN73824458). Please note that there should be no space between the letters and numbers of your trial registration number. We recommend manuscripts that report randomized controlled trials follow the CONSORT extension for abstracts.

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Conclusions

This should state clearly the main conclusions of the research and give a clear explanation of their importance and relevance. Summary illustrations may be included.

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In press article
Kharitonov SA, Barnes PJ: **Clinical aspects of exhaled nitric oxide.** *Eur Respir J*, in press.

Published abstract
Zvaifler NJ, Burger JA, Marinova-Mutafchieva L, Taylor P, Maini RN: **Mesenchymal cells, stromal derived factor-1 and rheumatoid arthritis [abstract].** *Arthritis Rheum* 1999, **42:**s250.

Article within conference proceedings
Jones X: **Zeolites and synthetic mechanisms.** In *Proceedings of the First National Conference on Porous Sieves: 27-30 June 1996; Baltimore*. Edited by Smith Y. Stoneham: Butterworth-Heinemann; 1996:16-27.

Book chapter, or article within a book
Schnepf E: **From prey via endosymbiont to plastids: comparative studies in dinoflagellates.** In *Origins of Plastids*. *Volume 2*. 2nd edition. Edited by Lewin RA. New York: Chapman and Hall; 1993:53-76.

Whole issue of journal
Ponder B, Johnston S, Chodosh L (Eds): **Innovative oncology.** In *Breast Cancer Res* 1998, **10:**1-72.

Whole conference proceedings
Smith Y (Ed): *Proceedings of the First National Conference on Porous Sieves: 27-30 June 1996; Baltimore*. Stoneham: Butterworth-Heinemann; 1996.

Complete book
Margulis L: *Origin of Eukaryotic Cells*. New Haven: Yale University Press; 1970.

Monograph or book in a series
Hunninghake GW, Gadek JE: **The alveolar macrophage.** In *Cultured Human Cells and Tissues*. Edited by Harris TJR. New York: Academic Press; 1995:54-56. [Stoner G (Series Editor): *Methods and Perspectives in Cell Biology*, vol 1.]

Book with institutional author
Advisory Committee on Genetic Modification: *Annual Report*. London; 1999.

PhD thesis
Kohavi R: **Wrappers for performance enhancement and oblivious decision graphs.** *PhD thesis*. Stanford University, Computer Science Department; 1995.

Link / URL
The Mouse Tumor Biology Database [http://tumor.informatics.jax.org/mtbwi/index.do]

Link / URL with author(s)
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Dataset with persistent identifier
Zheng, L-Y; Guo, X-S; He, B; Sun, L-J; Peng, Y; Dong, S-S; Liu, T-F; Jiang, S; Ramachandran, S; Liu, C-M; Jing, H-C (2011): Genome data from sweet and grain sorghum (Sorghum bicolor). *GigaScience*. http://dx.doi.org/10.5524/100012.

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  - MOV (QuickTime)
  - MPG (MPEG)
- Tabular data
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