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Effects of Compressed Work Schedules on Sickness Absence, Turnover and Working Hours

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Effects of Compressed Work Schedules on Sickness Absence, Turnover and Working Hours

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Abstract

Steadily increasing demand for personnel has led health care providers to seek more efficient uses of the healthcare workforce. One potential solution is to find ways of organizing work schedules that are more attractive and sustainable for workers. The primary objective of this article is to investigate how compressed work schedules (CWS), a scheduling practice with fewer but longer shifts, affects important employee outcomes such as sickness absence, turnover, and working hours. We do so by leveraging a nation-wide retrospective survey mapping the use and changes between different work schedules in the Norwegian municipal health and care sector, coupled with precise employee-level registry data, to conduct a quasi-experimental analysis of the impact of introducing CWS at the workplace on employees. Our preferred empirical approach involves leveraging observations of employees at workplaces that introduce CWS and workplaces that do not, in a differences-in-differences design. We find no effects on sickness absence or turnover. However, results suggest a modest positive effect on the working hours which increases by 5.8% after implementing CWS.

JEL Codes: I10, J22, J28, J45, J81

Keywords: Healthcare workers, health and care services, shiftwork, work hours, sickness absence, turnover

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1. Introduction

Across many contexts, healthcare providers struggle with employee recruitment and retention (WHO, 2022). For instance, a recent survey conducted among registered nurses in the US revealed that approximately one-third of the respondents express intentions to leave the profession (Berlin et al., 2023), and it is projected that there will be a shortage of 2.5 million nurses across OECD countries by 2030 (Scheffler & Arnold, 2019). Additionally, the demand for health and care services from aging populations further exacerbates the need for *more* healthcare personnel. Indeed, the World Health Organizations has described the growing disparity between labor supply and demand in Europe's health and care sector as a "ticking timebomb" (WHO, 2022). Consequently, managers and policymakers have an urgent need for measures that can utilize limited resources more efficiently while also providing sustainable and appealing work conditions for healthcare workers.

The services offered by health and care providers typically require round-the-clock staffing, making the need for shift work unavoidable.[1] Although the flexibility offered by shift work can be attractive for some employees (Stone et al., 2006; Griffiths et al., 2014), an extensive literature associates nonstandard working hours with a range of health issues (Bolino et al., 2020; Wu et al., 2022).[2] Previous research on nurses' intentions to quit the profession also points to the burden of shift work as a contributing factor (Shields & Ward, 2001; Peters et al., 2009; Dall'Ora et al., 2015, 2020). To improve working conditions for their employees and utilize scarce employee resources efficiently, several healthcare providers have implemented work arrangements with less rigid scheduling practices. However, there is a paucity of research that convincingly isolates the impact of such alternative work schedules on important markers of employee wellbeing. Indeed, the existing literature on work scheduling in the health and care sector is largely correlational, leading to a call among researchers for more rigorous research designs that can produce credible causal evidence on their effects (Baltes et al., 1999; Knauth, 2007; Vedaa et al., 2016, 2019a, 2019b).

Our study speaks to this call by providing new evidence of the impact on healthcare workers of a type of work scheduling that is becoming more widespread in Europe and the US (Griffiths et al., 2014), referred to as *compressed work schedules* (CWS). CWS organizes employee work hours in fewer, but longer shifts, allowing for more days off and longer rest in between workdays (Bambra et al., 2008). For example, using 12-hour shifts as opposed to the traditional 8-hour shifts, the number of shifts per day reduces from three to two, and the number of days present in a typical work week decreases from 5 to 3. The motivation behind implementing CWS has been related to reducing staffing costs (due to fewer overlapping hours), increasing continuity and quality of care, improving nurse recruitment, and reducing turnover (Dall'Ora et al., 2022).

It has been presumed that CWS will be beneficial for employee health, for example due to the fact that more rest between shifts might abate some of the detrimental health effects of shift work (Smith et al., 1998; Vedaa et al., 2019a). However, CWS might also improve working conditions

[1] Although shift work is particularly common in the health- and care sector it is also widespread elsewhere in the labor market. For context, 21% of all workers in the EU, and 32% in the United States, are working a shift schedule that deviate from the standard workweek (Eurofund, 2017; ILO, 2022). Presumably, our study might therefore be relevant for stakeholders in many other sectors as well.

[2] For example, shift work has been found to be associated with negative health outcomes such as sleep disturbances and fatigue (Shao et al., 2010; James et al., 2017), disrupted eating habits (Souza et al., 2019), and chronical diseases like diabetes type II and coronary heart disease (Kecklund and Axelson, 2016; Torquati et al., 2018). Moreover, there are studies linking shift work to poor mental health outcomes, in particular night work (Torquati et al., 2019). In addition to physiological and psychological disruption, shift work also involve social disruption as it involves "unsocial" working hours, potentially influencing work-life balance. Several studies have found that shift-workers report more family- and social life problems (ILO, 2022; Albertsen et al., 2007), which may influence health and wellbeing among employees (Eby et al., 2005; Jacobsen & Fjeldbraaten, 2018).

for healthcare workers in several other ways. First, decreasing the number of days worked implies lower costs and less time spent on commuting, which may reduce the burden of work. Second, increasing the length of each shift might also allow workers to complete more complex and varied tasks (Knauth, 2007), potentially leading to higher job motivation and satisfaction (Hackman & Oldman, 1976). Third, longer shifts also reduce the number of shift handovers needed, which are not only preferred by most patients, but have also been shown to potentially reduce margins of error (Knauth, 2007). Not the least, fewer working days could allow for more flexibility in balancing work and home life, increasing the time spent with family and friends (Richardson et al., 2007; ILO, 2022). In sum, such effects would suggest the possibility of substantial organizational gains in terms of higher job satisfaction, fewer absences, and less attrition (Baltes et al., 1999).

It is not, however, obvious that working longer shifts is preferrable to shorter shifts. If the marginal detrimental effect of another hour worked on employee health increases with shift length, longer shifts could lead to worsened health outcomes. Moreover, some studies have suggested that worker fatigue and increased risk of accidents could be an issue with longer shifts, with implications for patient safety and the quality of care provided (Rogers et al., 2004; Stimpfel & Aiken, 2013; Griffiths et al., 2014; Dall'Ora et al., 2016). Several studies suggest that extended shift length reduces sleep quality among employees, with potentially adverse implications for their health (see Knauth, 2007, and references therein). As such, introducing compressed schedules might increase absenteeism, but the evidence on such effects remains inconclusive with studies finding both reductions (Vedaa et al., 2019a, Peutere et al., 2021) and increases in absences (Ropponen et al., 2018; Dall'Ora et al., 2019, Larsen et al., 2020; Rodrigues Santana et al., 2020).

These conflicting effects make the impact of CWS on healthcare workers ambiguous. Indeed, the existing evidence on the effects of CWS is best described as mixed and inconclusive (Bendak, 2003; Knauth, 2007; Merkus et al., 2012; Dall'Ora et al., 2016; Deery et al., 2017; Vedaa et al., 2019a), with most studies limited to cross-sectional designs with a limited number of workplaces and employees. We extend this literature by applying a credible and rigorous research design that plausibly allows us to uncover estimates that have a causal interpretation. Specifically, we use a staggered difference-in-difference design in which we rely on variation in the timing of when CWS policies are introduced in a particular healthcare unit. This design allows us to recover the effect of introducing CWS in the workplace on important employee outcomes under the assumption that the exact timing of when CWS is introduced is independent of the trends in the outcomes we focus on.

We build our analysis around a novel dataset from the municipal health and care sector in Norway. To overcome the lack of information on work time scheduling in central data registries we conducted a survey directed at unit managers wherein they were asked to provide us with information about their unit's work scheduling policies for the period 2018-2022 as well as any changes that had been made in that period. The following services were surveyed: nursing homes, home care services, and various forms of assisted living facilities. We match this establishment-level data to employee-level registry data provided by Statistics Norway. The latter gives us information on employees' work conditions, such as workplace, contracted working hours, earnings, sickness absence, and a range of demographic indicators. Importantly, the unique employee and employer identifiers also allow us to follow workers from one job to another, capturing job mobility and turnover.

We use these data to focus on three central labor market outcomes for the affected employees, all of which represent pervasive issues in the health care sector. Specifically, we present evidence on the effect of CWS on sickness absence, turnover and working hours, three important indicators for efficient use of resources. For example, sickness absences present substantial direct and indirect costs to employers, including wages for sick and substitute workers, training costs, and the increased workload on remaining staff, which can compromise care quality due to decreased continuity, decreased time per patient and potentially lower competence of substitutes. The rate of sickness absences might serve as a proxy for employee health and wellbeing, highlighting the importance of favorable working conditions (although low absence rates do not always correlate with positive workplace environments, but rather, e.g., staff composition). Similarly, high turnover imposes costs through hiring and training replacements and the negative impact on quality and continuity of care. These costs might increase with CWS if the shift lengths are too strenuous for workers. Indeed, a few studies suggest extended shifts correlate with nurses' intentions to quit (Stimpfel et al., 2012; Dall'Ora et al., 2015), indicating a need for further research on the link between work schedules and turnover. In addition to turnover, the high prevalence of part-time work is associated with job insecurity, lower wages, and fewer benefits which may impact both individual health and job satisfaction (Horemans et al., 2016; Donnelly & Schoenbachler, 2021). Restricting the frequency of weekend work in combination with limited possibilities to reduce activity (and thereby staffing) during weekends contributes to the reliance on part-time positions. However, CWS offers a potential solution by enabling longer shifts that increase hours worked during weekends and potentially promotes full-time employment (Ingstad, 2015), though the extant body of evidence suggests a need for broader research to confirm these benefits.

We find that the introduction of CWS only has minor impacts on employee outcomes. Specifically, we find no positive or negative effect on sickness absence and turnover. However, we find a positive effect on working hours. According to our point estimates, working hours increased by 5.8% after implementing CWS. As such, the results indicate positive impacts on efficiency as measured by our outcomes since working hours seem to increase without an adverse effect on sickness absence and turnover.

Our results come with important implications for workplace policies in the health and care sector. While the use of CWS is increasing[3] among healthcare providers the research on their impact remains inconclusive. Our study therefore bridges knowledge gaps across two significant strands of literature, providing insights into both healthcare workers' labor supply and the broader economics of work hours organization. We provide evidence on the effects of workplace policies on health sector employees' sickness absence, turnover, and part-time work prevalence, all of which are areas of growing concern due to their high incidence in the sector (Krane et al., 2014; ILO, 2023). While tailoring scheduling practices more towards employees' preferences have been proposed as potential solutions for improving job satisfaction and retention among healthcare workers (Lum et al., 1998; Shield & Ward, 2001), the literature lacks comprehensive causal analyses on the effects of compressed work schedules on employee outcomes (Deery et al., 2017), highlighting the need for rigorous evidence before widespread implementation of such policies. Additionally, our research contributes to the line of research on the effect of how scheduling of work hours affects productivity and efficiency, emphasizing the underexplored aspect of how the

[3] For example, in Norway, the setting for our study, we find that the share of establishments using CWS doubled in the period 2018-2022. As of May 2022, 12 percent (174 of 1423) of our sampled establishments use CWS.

distribution of work hours affects workplace outcomes beyond immediate productivity, such as the long-term effects of weekly shift schedules. While studies like Spiegel et al. (2014) and Amendola et al. (2011) suggest longer shifts may improve productivity, others (Brachet et al., 2012; Pencavel, 2015; Collewet & Sauermann, 2017) show a productivity decline in extended shifts' latter hours due to worker fatigue. Our paper provides new insights by examining the short- to medium-term outcomes of shift schedules, thereby complementing existing research focused on workday-specific hours and productivity.

2. Institutional settings

2.1 Health and care services

The Norwegian health and care sector is public, funded through taxes and is based on a principle of universal access. The size of this sector has increased during the last decades, and as of 2021 15,4% of all employees in Norway were employed within the health and care sector (see NOU 2023:4, p.26).[4] While most hospitals are managed and financed by the central government, local authorities at the municipal level are responsible for providing primary health care. The municipal health and care services include services like nursing homes, home-based services, public physiotherapy service, substance abuse and mental health services and the general practitioner system (NOU 2023:4, p.55). In this paper, we focus on institutions within the municipal health and care sector providing round-the-clock services, such as nursing homes, home based services, and housing facilities.

To provide insights into the Norwegian healthcare context, we present some descriptive statistics (as of May 2022) for all employees in Norway and for employees working in the services we focus on in this study.

[4] The health and care sector are here including the SIC-codes 86, 87 and 88.1. For an explanation of the Standard Industrial Classification 2007 (SIC 2007), see Statistics Norway (2024).

Table 1. Descriptive statistics employment records, May 2022

	All employment records	Study population (Nursing homes, home-based services, and housing facilities*)
N	2,600,933	205,448
Mean age	42.5	41.9
Women (%)	49.1	83.1
Shift-work (%)	14.8	81.5
Contracted working hours		
% working full time	67.9	28.7
Mean full-time equivalent (%)	81.8	62.2
Sickness absence (calendar days)	1.8	2.8

Source: Authors own calculation based on data on all working individuals registered as residents in Norway, aged 20-70 and registered as employed in May 2022 according to the employer/employee register.[5] *= Nursing homes, home-based services and housing facilities are defined as 86.901, 87.1, 87.2, 87.301, 87.302, 87.303, 88.101 Standard Industrial Classification 2007 (SIC 2007), see Statistics Norway (2024).

According to Table 1, around 8% (215,014 out of 2,752,633) of the entire work force is employed within our focal institutions (nursing homes, home-based services, and housing facilities.) Compared to the working population at large, the study population has a large proportion of women and shift-workers. While 15% of the entire working population work shift, a significant 82% of the study population do so. In addition, a majority (83%) of the study population are women. Compared to the general population, the incidence of sickness absence is high and the share of employees working full-time is low for the sector of interest. The mean calendar days of sickness absence within this sector is 2.8, being approximately 35% higher than the working population in general. In addition, only 29% work full-time and the average full-time equivalent per employee is 62%.

2.2 Regulation of work hours

The services in our study require around-the-clock staffing, thereby making it necessary to organize the work in shifts. Shift work can be structured in several ways. In contrast to work schedules where employees work day, evening and night shifts in a given period (e.g., a week), the health and care sector in Norway operate rotating shift schedules in which the same employee can alternate between different shifts within the same week. This type of rotating shift schedules includes two-shift rotations (day and evening shifts with separate staff working night shifts), or three-shift rotations (including day, evening, and night shifts), which rotate over periods of, e.g., 6 weeks (Ingstad, 2015). It is also common within the health and care sector in Norway to work

[5] Some of the employments records in the employer/employee register is not active and some is not registered with any contracted working hours. These are excluded from the sample. The sample criteria are described in detail in table A1

6-8 hours shifts during the day and evening and longer night shifts (9-10 hours) (Garde et al., 2019).

The Work Environment Act §10-4 regulates work hours in Norway. While a regular work week consists of 37.5 work hours, the work week for shift workers is regulated to be 35.5 hours or down to 33.6 hours[6]. Shift workers have the right to receive a work plan that includes workdays and hours. The main rule is that working hours cannot exceed 10 hours within 24 hours or 48 hours within 7 days. Shifts lasting longer than 10 hours require an agreement with the local union and shifts longer than 12.5 hours require an agreement with central union representatives. Agreements of extended shifts must always be voluntary for the worker, and the agreements must consider the health and welfare of workers in addition to being discussed with, and be recommended by, the employee representative. Extended shifts (12 hours or more) makes it possible to reduce the number of shifts per day from three to two.

Within the traditional work schedule for health workers in Norway, employees usually work every third weekend (Ingstad, 2015). The traditional work schedule combined with round-the-clock operations and limited opportunities to reduce staffing during weekends, has led to extent use of part-time positions to fill “gaps” in the schedules. By introducing CWS (including 12-14 hours shifts), it is possible to reduce the frequency of weekends worked to every fourth weekend and establish a culture of full-time work (Ingstad, 2015). Why the traditional work schedule leads to extensive use of part-time work can be mathematically illustrated (see ibid); Full-time employed shift workers with traditional length of shift usually work 15 days within a three-week period. Two out of these 15 days are weekends, meaning that 13% of the working days are weekends. However, within a week, two out of 7 (28%) days are weekends. As the patients' need for care is constant during the week, 28% of the working time should be performed during weekends. Hence, the work schedule is incompatible with full-time work for all employees. In fact, it may be possible to reduce activity to some extent during weekends, such as not offering baths during weekends, no complete bed change or no doctor’s visits. If 20% (instead of 28%) of the working hours need to be performed during weekends, the traditional work schedule still includes too few working hours during weekends to be compatible with full-time work for everyone.

2.3 Sickness insurance

Norwegian sickness insurance is compulsory and regulated by The National Insurance Act §8, providing coverage for all employees who have worked with the same employer for a minimum of four weeks. It offers 100% coverage from the first day of absence.

[6] Employees with a three-shift schedule may be entitled to reduced working hours down to 33.6 hours depending on the extent of job during weekends, evenings and Sundays.

Employees have the right to self-certified sick leave, which means that for short spells of absence they can inform their employer they are unable to work due to an illness or injury without providing a medical certificate. [7]

During the initial 16 days of absence, the employer covers the cost of the absence (known as the employer period), while spells of absence exceeding this initial period is covered by the social insurance scheme administered by the Norwegian Labour and Welfare Administration.

Upon presenting a physician's certificate, individuals on sick leave are eligible for a 100% wage replacement and job protection for up to one year. The 100% replacement rate is however capped at six times the base amount in the Norwegian pension system, in 2024 roughly equating to €63 000. However, all public sector employees receive a 100% replacement rate regardless of their income.

3. Data and definition of variables

Our analysis utilizes data from two sources: a survey of establishments in municipal nursing homes, home-based services, and assisted living facilities, and administrative records from Statistics Norway. We have merged these datasets at the establishment level. The following sections detail each source independently, followed by an overview of our sample selection methods and data linkage process.

3.1 Shift-work survey among establishments in the municipal health- and care sector

All establishments in Norway registered in the Central Coordinating Register for Legal Entities (Entity Registry) that met the SIC code criteria outlined in Table 1 (excluding certain types such as cantinas, catering services, offices, and administration) were invited to participate in a web-based survey. In May 2022, we emailed survey invitations to all 356 Norwegian municipalities, asking them to forward the invitations to relevant establishments in their municipality. We also encouraged establishment managers to respond. Each email included a list of these establishments, as per the Entity Registry. We customized the invitation letters for small, medium, and large municipalities and sent up to two reminders to establishments that hadn't responded by May-June 2022. The survey remained active until the following August. For more details on the survey, see Bernstrøm et al. (2022).

From our initial list of 4,178 establishments, we received 1,587 survey responses. Of these, 40 responses were excluded due to a lack of consent for data linking. We identified 8 responses representing multiple establishments, leading to 23 duplicates. We also removed responses that

[7] The number of calendar days of self-certified sickness absence an employee is entitled to, varies between employers, commonly 3 days maximum 4 times a year, or 8 days with a maximum of 24 calendar days within a year, depending on employer agreements. All employees within public sector were entitled to the latter arrangement until January 2019 (Proba, 2016). 99 percent of the establishments who responded to the survey belongs to the public (municipal) sector (Bernstrøm et al., 2022). From January 2019 employers could choose whether their employees are given an extended right to self-certificate absence spells or not.

were blank, consisted solely of 'don't know' answers, or stated that shift work was not part of the work schedule. This resulted in 1,541 valid responses. For 85 establishments, we received multiple responses; these were combined into 196 aggregated responses to represent these establishments accurately. Consequently, we had valid responses from 1,427 establishments, corresponding to a response rate of 34.1%. For a detailed account of how certain establishments were excluded from the analytical sample, we refer to Table A2 in the appendix. When responding, it was possible to answer, "don't know" or "other". In our analysis we exclude "don't know" and "other" answers, resulting in the number of valid responses varying from 1,330 to 1,423, being lowest in 2018 and highest in 2022.

The survey included questions about the type of work schedule as of May 1st for each of the five years between 2018 and 2022. This provided us with an overview of the situation each year and any changes during the specified period. Establishments reporting extended shifts were asked some follow-up questions such as whether employees work extended shifts throughout the week or only during weekends, the length of extended shifts and whether the extended shifts were day or night shifts (see Bernstrøm et al., 2022 for an exact definition of all the question asked in the survey).

3.2 Administrative data

We supplement our survey data with high-quality registry data from Statistics Norway from the period 2018-2022. Every resident and establishment in Norway are assigned a unique encrypted personal number. These identifiers enable us to link individual workers to their respective employer establishments together with information from various administrative registries, including social insurance and population registers. Consequently, we can link the de-identified data records of every worker employed by the establishments that took part in our survey.

For each employee, we collect demographic characteristics (including gender, age, marital status, number of children), educational attainment and data that pertains to their employment record. The employer-employee register provides detailed information about each individual's work history, including earnings, start and end dates for specific jobs as well as type of workplace (group of service), weekly contracted working hours and type of work (shift work or not). We also include information about all certified sickness absence spells (see section 2 for a more thorough description about rules regarding sickness absence in Norway).

3.3 Definition of outcomes and compressed work schedules

Definition of compressed work schedules. Within our survey, we observe that a large fraction of establishments report having extended shifts, have extended shifts only during the weekends. Extended shifts during weekends will also imply fewer days at work, but to a much lesser extent compared to extended shifts throughout the week. In this study, we define compressed work schedules (CWS) as schedules of extended shifts (10-23 hours) throughout the workweek (not only during weekends).

To identify establishments with compressed work schedules, we combine responses from two questions in the survey. The first question inquires how the working day is organized, where respondents could select from the following options: 1) two-shift rotation schedule, 2) three-shift rotation schedule, 3) extended shifts (10-23 hours), and 4) round-the-clock shift (24 hours or more). The second question asks whether employees work extended shifts throughout the week or only on weekends. For an exact definition of the questions asked see Table A3 in appendix. We classify an establishment as having compressed work schedules if the respondents answer extended shifts (option 3) in the first question above, and answer having extended shifts throughout the week in question 2 above. We define CWS at the establishment level implying that within an establishment defined as having CWS, there also will be workers who have other schedules.

Outcome variables. We examine three outcome variables[8]: 1) sickness absence, 2) turnover, and 3) working hours. Sickness absence is measured at the individual level as the total number of calendar days absent in May each year. Second, we create a measure of turnover for each establishment, following Røed and Fevang (2007). We define turnover as the fraction of employees that are "reshuffled" from one period to the next one. More formally, turnover is defined as $\min(in_{jt}, out_{jt}) / n_{jt-1}$, where in_{jt} is the number of new workers in the establishment *j* in year t, who did not work in the establishment *j* in year t-*1*, out_{js} is the number of workers who left the establishment *j* between year t-*1* and *s*. n_{jt-1} is the total number of workers in the workplace *j* in year t-*1*. Finally, we measure working hours as the contracted share of a full-time work position (full-time equivalent) at the *individual level*. That is, the fraction of a contracted full-time job each worker works. For example, if the contracted work hours in a full-time job is 35.5 hours per week (which is common for shift-workers in the health- and care sector in Norway) an employee working 20 hours per week will have a full-time equivalent of 0.563.

3.4 Descriptive statistics

In this section we provide some descriptive statistics, starting with the establishment survey. Some establishments have several types of shift schedules simultaneously. The most common way to organize shifts within our sample is a two-shift rotation schedule. Between 80 and 90 per cent of the establishment managers report having this type of work schedule in 2018-2022. Extended shifts (10-23 hours) have become steadily more widespread. During the study period 2018-2022, the share of establishments reporting extended shifts has more than doubled, from 21 to 43%. 24-hours shifts are quite rare within this sample and are mainly concentrated within assisted living facilities for persons with intellectual disabilities (Fevang et al., 2024).

Figure 1 displays the share of establishments who in the survey report having employees who work extended shifts. A large share of establishments report having extended shifts on weekends only, which is probably related to filling "gaps" in the work schedules during weekend (see Ingstad, 2015). Having extended shifts throughout the week (CWS) is much less common, but the fraction

[8] Our pre-registered outcome variables are sickness absence and turnover. In addition, we include working hours as an outcome variable, as increasing working hours is often one of the main reasons why establishment within this sector implement CWS (Ingstad, 2015) and since working hours may interact with sickness absence. In addition, it is an important measure of efficient use of resources in this sector where the prevalence of part-time work is high.

of CWS has also doubled. In 2018, 6% of the establishments reported having CWS which increased to 12% in 2022.

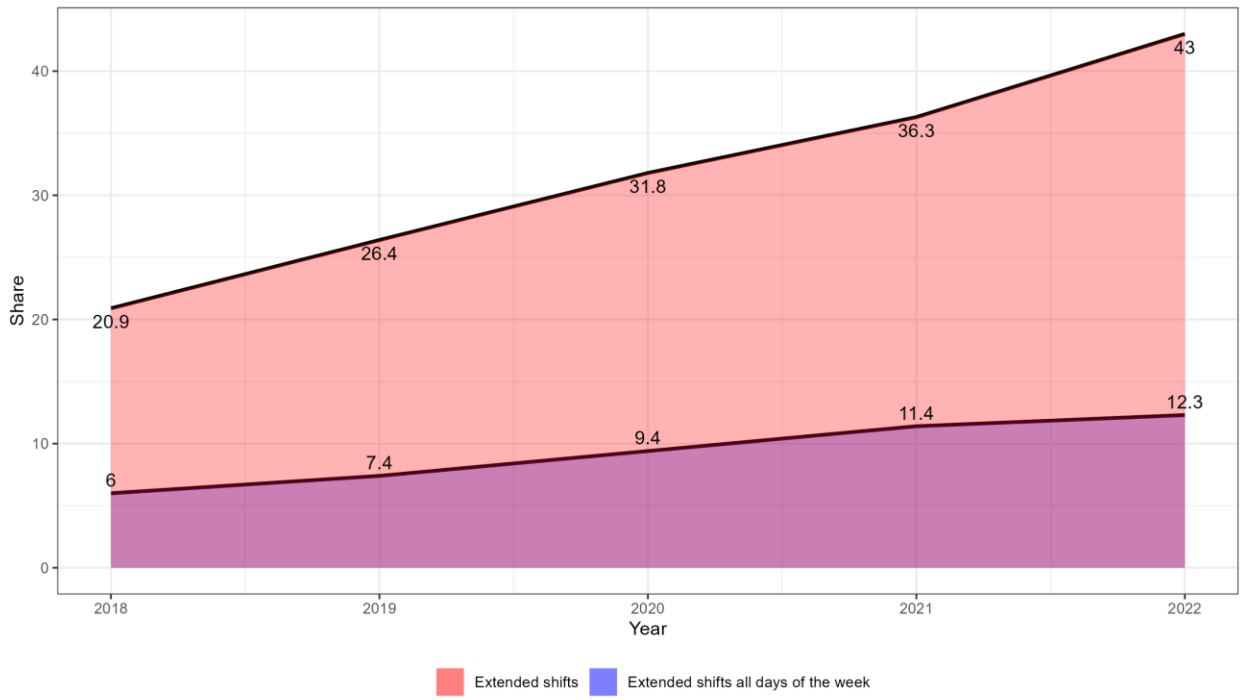

Figure 1. Share of establishments reporting extended shifts

Table A4 in the appendix provides an overview of establishments reporting extended shifts in May 2022. Most of the establishment report having extended shifts combined with a two-shift or three-shift rotation schedule. Only 14% had extended shifts only. For employees working extended shifts, establishment managers report that the most common frequency of weekends was every fourth weekend. The establishment managers were also asked about the frequency of weekends among workers not working extended shifts. In this group the most common frequency of weekends was every third (Fevang et al., 2024). 95% of the extended shifts last between 12 and 14.5 hours. Shifts of this length are compatible with dividing the 24-hour day into two shifts rather than three.

Table 2 gives a description of the sample where the establishment survey is merged with registry data as of May 2022. The sample is restricted to shift-workers aged 20-70.[9] Mean age in this sample was 41 and the share of females 85%. Almost 60% had formal health and social care education. When it comes to type of services, nursing homes account for 43% of the employees in this sample, home based services (29%) and the rest was employed within various assisted living facilities. Finally, we present the mean and the distribution of our outcome variables. Mean calendar days of sickness absence in May 2022 was 2.8 where 15% is absent for 1 day or more.

[9] 87% in the sample of establishments are shift-workers (see table A6).

The average share of a full-time equivalent was 62%. Some employees had very small positions and almost 40% had positions accounting for less than 50% of a full-time position. Only 26% worked full-time. Most of the employees (70%) worked in establishments with turnover rates between 10 and 30%.

Table 2. Descriptive statistics. Establishment survey combined with register data. May 2022

Number of employment records	72,291
Number of establishments	1,427
Mean age	41.0
Distribution of age (%)	
20-29	27.9
30-39	21.3
40-49	18.5
50-59	20.1
60+	12.2
Women (%)	85.2
Group of health- and social care professional (%)**	
Health- and social care professionals with (at least) bachelor degree	26.7
Health- and social care professionals with diploma	32.4
Employees without formal health and social care education	40.9
Type of service (%)	
Nursing homes (ISIC-codes 87101, 87102, 87201, 87301)	42.5
Home-based services (ISIC-codes 86901, 88101)	29.2
Assisted living facilities for people with intellectual disabilities (ISIC-code 87203)	13.2
Assisted living facilities for elderly and people with functional disabilities (ISIC-codes 87202, 87302, 87303)	15.1
Mean calendar days of sickness absence	2.8
Calendar days of sickness absence (%)	
0	84.5
1-7	4.5
8-30	4.5
31 (the entire month)	5.7
Mean % of contracted fulltime-equivalent	61.7
Distribution of contracted fulltime-equivalent (% in each group)	
<25%	24.3
25-49%	14.4
50-74%	17.3
75-99%	18.2
100%	25.7
Distribution of turnover (% in each group)	
<10%	11.9
10-19%	34.7
20-29%	35.3
>29	14.3
Missing[10]	3.8

*The sample criteria is described in Table A5, **Definiton of health-and social care professional is described in table A6

[10] A small share of establishments has missing on turnover due to the fact that there are no recordings of them prior to 2022.

4. Empirical strategy

In this section we describe our empirical framework. We will discuss the standard event study methods and their limitations in our context. We exploit the recent advances in the difference-in-difference literature to overcome these limitations and discuss how they apply to our settings.

A common method to estimate the impacts of changing treatments involves utilizing an event study regression, which incorporates both unit and time fixed effects. In the specific scenario we are examining, the equation used to assess the effect of changing to CWS on the outcomes of interest, is:

$$Y_{it} = \sum_{j=-3}^{3} \beta_j 1(CWS)_{ij} + \mu X_i + \delta_i + \gamma_t + \varepsilon_{it} \tag{1}$$

where Y_{it} is the outcome measure for unit *i* in year *t*. In our setting a unit is an establishment. The indicator variable $1(CWS)_{ij}$ tracks the year surrounding the change to CWS for unit *i*, in our case with indicators for the set $j \in \{-3,3\}$. In each case, the indicator takes the value 1 for units exposed to the treatment, *j* periods removed from the initial treatment exposure, and 0 otherwise. X_i is a vector of covariates and δ_i and γ_t are unit and year fixed effects respectively. The coefficient of interest is β_j, representing the Average Treatment Effect on the Treated (ATT), that is, the average effect of the treatment among units exposed to a switch to CWS. The estimated $\hat{\beta}_j$ is interpreted as the average effect of the treatment on the outcome of interest *j* periods following the switch to CWS. The primary assumption in such an event-study design is that without the treatment, the counterfactual outcome trajectory for the treated group would align with the actual trajectory experienced by the untreated group (those not participating in the treatment), referred to as the parallel trend assumption.

A limitation of this approach is that it might not yield precise results in scenarios where treatment effect heterogeneity is likely, that is, where the effects vary across different establishments or evolve over time. Particularly, traditional event studies tend to use units treated earlier as control groups for those treated at a later stage, a method that might lead to biased estimates due to the dynamic nature of the treatment effects. To overcome this limitation, we utilize the difference-in-differences and event study procedure introduced by Callaway & Sant'Anna (2021) (see also Baker et al., 2022, and Roth et al., 2023, for an overview of recent developments in this methodology). This approach acknowledges the variability in treatment timing, thus effectively capturing dynamic treatment effects. It facilitates the calculation of the group-specific Average Treatment Effect on the Treated (ATT(g,t)), signifying the group-time average treatment effects for a specific period *t* for the group of units first treated at time *g*. For example, in our context, we observe switches to CWS in the years 2019, 2020, 2021, and 2022. We can therefore group the treated establishments into treatment cohorts *g*, consisting of the sets of establishments making the switch in the same year. Additionally, we monitor the periods leading up to their transition to CWS (referred to as years *t*). Hence, the ATT is defined as follows:

$$ATT(g,t) \ = \ E[Y_t * \ (1) - Y_t * \ (0) | G_g \ = \ 1] \tag{2}$$

where G_g is a dummy variable that equals one if the unit belongs to the treatment group treated in time period g, $Y_t(1)$ and $Y_t(0)$ represent the actual outcome at time t for the treated units and the potential outcomes for those units not yet treated, respectively. In our analysis, we employ a control group of units that have never been treated (denoted as C) as a proxy for what would have happened had the unit never introduced CWS in the first place. Callaway & Sant'Anna (2021) demonstrate that, under the assumption that both control and treatment groups follow counterfactual parallel trends, in the general approach of Equation (2) is expressed as follows:

$$ATT(g,t) = E\left[Y_t - Y_{t-1} \middle| G_g = 1\right] - E[Y_t - Y_{t-1}|C = 1] \quad (3)$$

where $\left[Y_t - Y_{t-1} \middle| G_g = 1\right]$ represents the progression of the outcome for the treatment group, whereas, and $[Y_t - Y_{t-1}|C = 1]$ is the outcome for the group that was never treated. That is, (3) estimates the average treatment effect at time *t* for members of cohort G treated in period g. In the context of estimating the effect of establishments changing to CWS, ATT (2020,2022) is the average treatment effect in 2022 for the cohort of establishments that changed to CWS in 2020. Important for why we implement this method is that Equation (3) avoids comparisons across groups treated at different times, thus addressing the issue of using units treated earlier as controls for those treated later. Equation (3) also provides unique estimates for each cohort of units that transitioned to CWS within the same year.

The estimated results from equation (3) reflect the group-time average treatment effects. However, we aggregate these group-time average treatment effects into a smaller number of parameters, following the dynamic aggregation approach proposed by Callaway & Sant'Anna (2021). This is done because we anticipate that the causal effect of transitioning to CWS will vary depending on the number of years since the change to CWS occurred. Therefore, for each time period *t* relative to an establishment's switch to CWS, we calculate the average of the ATT across all groups. This average is then weighted by the sample share of each cohort, yielding the average treatment effect among those establishments that have experienced CWS for exactly *t* periods. We also calculate a single, overall point estimate, by taking the average of the aggregated relative time estimates when $t \geq g$.[11]

In using the event-study framework introduced in Callaway & Sant'Anna (2021), we adopt their recommendation of using a variable base period. This approach differs from standard event studies in that it does not include an omitted category.[12] Instead, each coefficient quantifies the effect of the switch to CWS, *t* years subsequent to the change. Here, *t* represents the running variable on the x-axis, which is the number of years. The coefficient is the average treatment effect on the treated (ATT) j years after the change, averaging across the event-time coefficients for cohorts treated in each respective year.

[11] For a full discussion of this method, see Section 2 of Callaway and Sant'Anna (2021) and section 3 of Callaway (2022). We calculate all treatment effects using Callaway and Sant'Anna's R Package did, version 2.1.2. See https://bcallaway11.github.io/did/ for more information on this package.
[12] See https://bcallaway11.github.io/posts/event-study-universal-v-varying-base-period for a discussion

In order to evaluate whether our model can provide causal estimates we examine the assumptions underlying the DID-estimator with multiple periods and varying treatment timings. The first assumption is based on the traditional DID-estimator, while the subsequent assumptions address the variable treatment timing across different establishments. For a more technical discussion, see Callaway (2023).

The initial assumption, the parallel trend assumption, says that the potential outcomes for both untreated and treated groups would have been similar on average if not for the treatment. In our context, this means that treated and control units would have followed parallel trends without the introduction of CWS. While we can't directly test this assumption, our visual approach allows us to examine outcome trends in the years before the adoption of CWS, and as will be evident in the next section, seems to hold quite well. We also compare observable characteristics between treated and untreated units. Changing shift schedules, and in particular introducing CWS, is a process that takes time, and it is reasonable to assume that the employees are informed about upcoming changes in the work schedule well in advance, e.g., 1-2 years. We assert that the assumption of parallel trend appears reasonable in our setting based on our visual inspection of the outcomes in the two groups before treatment. Likewise, as there is no difference between the treatment and control group before treatment occurs, we do not see any indication of anticipation effects on our outcome variables.

Second, we assume that once an establishment adopts CWS, it continues to use it. In our analysis, we identified 8 cases where establishments switched from CWS to another work schedule. These cases were excluded from our sample.

Finally, the question of covariates in the DID-setting have been extensively discussed in recent DID-literature, see for example Caetano and Callaway (2023) and Roth et al. (2023). We have rich panel-data information about the employees in our sample. Yet, regardless of whether these controls are measured prior to the introduction of the change to CWS, as X_i, or as a time-varying covariate ($X_{i,t}$), introducing these controls may only be done in the event when either X_i or $X_{i,t}$, is unaffected by the treatment. We are not able to assume that these time-varying covariates are not a function of the treatment itself and will thus not include them in the regression.

4.2 Sample selection in the analysis

Sample selection. The focus of our analysis is to use variation on establishment level to gauge any potential changes in the outcomes of interest for the establishments. We focus on outcomes at the establishment level for three reasons.[13] The first is the high turnover in the sector, which makes it difficult to set non-arbitrary conditions for assigning employees to establishments when establishing treatment exposure levels. Examples of issues with no clear solution is how many months a worker must be observed with a treated establishment before assigning the worker as treated, and how to use information about sickness absences among treated workers who in later periods might work somewhere else. The high turnover makes individual-level analysis

[13] In the pre-analysis plan we outlined analyses both at the individual and establishment level. For the three reasons mentioned in this paragraph, we only run analyses at the establishment level.

particularly complicated due to the second reason, which is that we asked establishments about their working schedule per the month of May each year. As we do not have specific information about when any change occurred, only that it happened at some point between year t and year $t-1$, we do not observe to what extent employees working for an establishment for only part of that year was present during the CWS regime. Similarly, our third reason is that the information about CWS is measured at the establishment level only. We do not have information about which employees in an establishment work the extended shifts. In our data we see that most of the establishments (around 90%) report having employees working extended shifts also report having two- or three- shift rotation schedules. Hence, only a small part of the treated establishments consists only of employees working extended shifts.

As such, we circumvent these issues by identifying all shift-workers between the ages of 20 and 70 who worked in an establishment in May each year (excluding those who quit during that month). [14]

In this study, a treated establishment refers to any establishment transitioning from two- or three-shift schedules to CWS. Conversely, the control group comprises establishments that persist with two- or three-shift schedules for the duration of the sample period. Consequently, certain establishments are excluded from the sample. Specifically, establishments operating on a 24-hour shift basis are omitted from both the treatment and control groups. Despite being a variant of extended shifts, 24-hour shifts represent an extreme case and, in our assessment, diverge significantly from other forms of extended shifts as well as traditional two- or three-shift schedules. Additionally, we exclude establishments transitioning from extended weekend shifts to CWS. This exclusion aims to ensure the integrity of a "pure" control group, characterized by the absence of any form of extended shifts. They are also excluded from the treatment group as a switch from extended shifts during weekends to CWS represent a different treatment intensity then the change from two- or three-shift schedules. Consequently, the mechanisms from the estimation would be difficult to disentangle as the establishments change from two completely different shift schedules.

Out of 1,413 establishments, the limitations we place on the definition of treatment of control leaves us with a total sample of 1,068 establishments, where 70 establishments are treated and 998 constitutes the control group. The establishments consist of 240,641 employment records[15], and we place no restrictions on the sample regarding the number of workers identified in each establishment. As discussed in the previous section, the regression weight the establishments by the number of workers in each establishment. Table 3 below summarizes pretreatment statistics regarding the treatment and control groups of our sample, as well as background characteristics of the establishments and a joint F-test between the two groups.

[14] See Table A5 for a definition of the sample.

[15] Each employee could be recorded up to 5 times (once a year during the period 2018-2022). Some employees also have several employment records within a year, as some have several jobs.

Table 3. Pretreatment statistics of treatment and control establishments

	Control (n=998)			Treatment (n=70)			
	N	Mean	SD	N	Mean	SD	Test
Outcome measures							
Sickness absence (calendar days in May)	998	2.601	1.468	70	2.80	3.764	F=0.891
Turnover	998	0.181	0.1	70	0.156	0.108	F=3.88**
Share quit	998	0.227	0.129	70	0.221	0.188	F=0.126
Contracted working hours (measured as % of full-time equivalent)	998	58.608	8.675	70	59.587	10.535	F=0.808
Other measures							
Share with health-related education*	998	0.548	0.162	70	0.523	0.162	F=1.482
Share with higher health-related education (at least bachelor)*	998	0.269	0.133	70	0.212	0.107	F=12.222***
Share women	998	0.866	0.131	70	0.852	0.165	F=0.695
Age	998	42.121	4.164	70	42.65	4.772	F=1.036
Share immigrants	998	0.147	0.131	70	0.146	0.121	F=0.002
Share married	998	0.406	0.129	70	0.433	0.166	F=2.777*
Share with children under age of 18	998	0.384	0.116	70	0.396	0.149	F=0.637
Share with children under age of 6	998	0.157	0.078	70	0.169	0.13	F=1.338
Number of staff	998	55.608	49.886	70	43.443	37.082	F=4.006**

Note: *For a definition of health-related education, see table A6. The variables are defined in 2018, or the first time the establishment is observed.

According to Table 3 prior to treatment sickness absence is slightly higher in the treatment group (2.8 calendar days) compared to the control group (2.6 calendar days), but the difference is not significant. The turnover rate is significantly lower (15.6%) than in the control group (18.1%), while the share quitting is almost the same between the groups. Contracted working hours is on average 59.6% of full-time position in the treatment group being slightly higher than in the control group, but the difference is not significant. For most of the other characteristics (health-related education, age, share of women, share immigrants) there is no significant differences between the treatment and control group. There is a significantly higher share of married employees in the treatment group and the size of the establishments (measured as number of staff) is significantly lower in the treatment group. In addition, in the treatment group, the share of employees with a higher health-related education is higher.

5 Results

In this section, we present estimates of the impact of transitioning to a compressed work schedule on key employee outcomes, using the methodological framework of Callaway & Sant'Anna (2021). We start by presenting the average treatment effect of the three primary outcomes, before looking into the effects in the context of event studies. Thereafter, we discuss the findings, before looking at the robustness of the main findings.

5.1 Main estimation results

Table 4 presents the aggregated treatment effect (ATT) estimates. The results are obtained by estimating the sample analogue of equation (3) from the previous section. Overall, Columns (1) and (2) show that the aggregated ATT on sickness absence and turnover is statistically insignificant at conventional levels. The point estimates for both sickness absence (1) and turnover (2) are relatively precise null effects, but with large confidence intervals, meaning we cannot rule out that there may be cases including both positive and negative effects. In Column (3), we find a positive effect on contracted working hours, significant at the 5% level, suggestive of an increase of 3.5 percentage points in average full-time equivalent as a result of the switch to CWS. As the average percentage of full-time equivalent is 60, this corresponds to a 5.8 percentage point increase in working hours.

Table 4: Aggregated average treatment effect estimates of the effect of change to CWS

	Sickness absence	Turnover	Work-hours (measured as % of full-time equivalent)
	(1)	(2)	(3)
ATT (SE)	-0.0107 (0.226)	-0.001 (0.016)	3.493 (1.228)**
95% CI	[-0.454 0.433]	[-0.033 0.030]	[0.985 6.0043]
Observations (Year*Establishments)	4,474		

Notes: This table presents Difference-in-Difference (DiD) estimates of the effect of changing to CWS on the three primary outcomes. All models are estimated using the Callaway and Sant'Anna (2021) DiD estimator using the dynamic aggregation. The first panel presents the aggregated ATT across all time-periods. All results are obtained from estimating the sample analogue of equation (3). *** $p<0.01$; ** $p<0.05$; * $p<0.10$

In Figure 2, we examine the dynamics of these estimated effects using Callaway and Sant'Anna's (2021) event study aggregation. Specifically, we explore how the effects vary by the length of exposure to CWS, regardless of which year the establishments made the switch. This analysis is crucial for two reasons: first, it allows us to look beyond the immediate impact to investigate the presence of dynamic, longer-term effects resulting from the switch to CWS, and second, it enables us to assess whether establishments that switched to CWS and those that never changed were statistically similar in terms of outcome dynamics during the pre-treatment periods. This assessment is used to evaluate the plausibility of the parallel trend assumption.

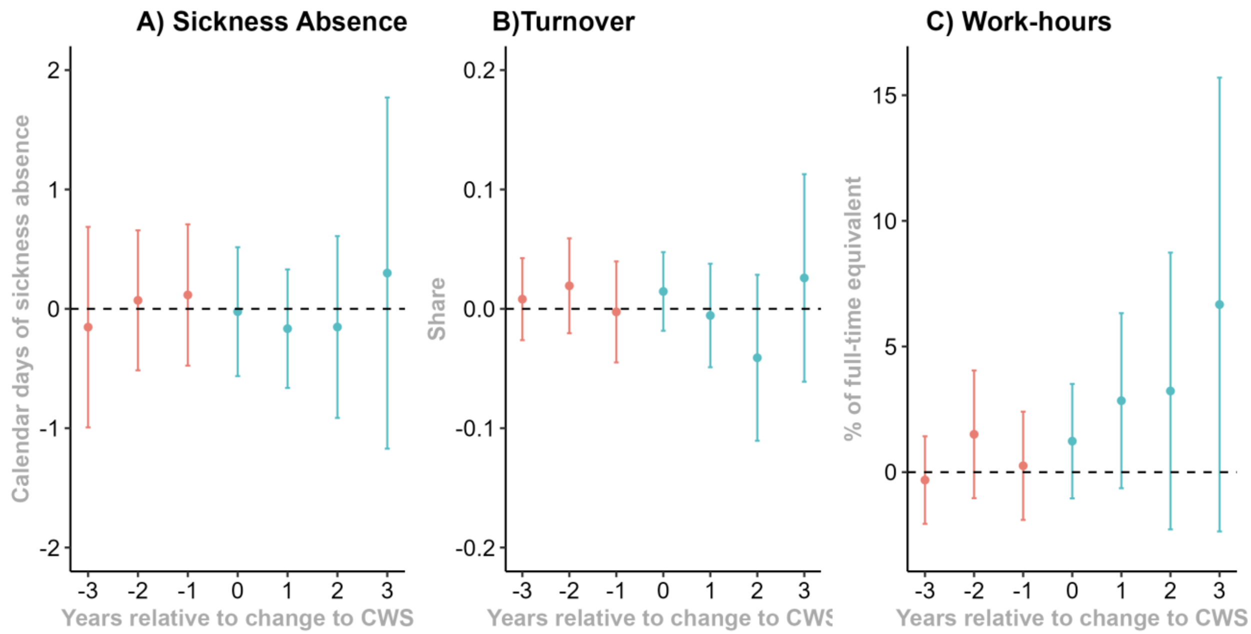

Figure 2. Event study estimates of a change to CWS, by outcome.
The exact point estimates and confidence intervals are provided in table A7-A9

Notes: This figure presents event study estimates of the effect of CWS on three different outcomes. The model is estimated using the Callaway and Sant'Anna (2021) DiD estimator as described in Section 4 at the establishment level. Change to CWS is defined in Section 2. ATT`s are estimated for each period using varying base period. The figure shows bootstrapped 95% simultaneous confidence intervals. The results are obtained from estimating the sample-analogue of equation (3) in Section 4. Sampling weights employed and standard errors are clustered at the panel (establishment) level. Capped spikes represent 95% confidence intervals.

Panel A shows how sickness absence is affected by length of exposure to CWS. The ATT-estimates for the pre-treatment periods are statistically indistinguishable from zero, supporting the plausibility of the parallel trend assumption. A marginal increase is observed from year -3 to year -1, but this increase is not statistically significant, suggesting that establishments appear to not be positively selected based on the dynamics of sickness absence prior to switching to CWS. After the switch, no effect on sickness absence is evident for the switching establishments. Indeed, throughout the entire observation window, the point estimates are close to zero. However, the confidence intervals are wide.

The pre-treatment estimates for turnover (Panel B) are not significantly different from zero, which again supports the plausibility of the parallel trend assumption. In the post-treatment dynamics, we observe a small, insignificant increase at t=0. In subsequent periods, however, the effect appears negative and insignificant. In any case, these estimates suggest that the change to CWS did not induce a major change in the rate of turnover. As with sickness absence the confidence intervals are in some cases wide, ranging from an increase in turnover of 5 to a decrease of 5 percentage points for the most imprecise estimates.

In Table 4, the aggregated effect on working hours was significant at the 5% level. Panel C shows that there is no significant change in working hours in the years immediately following the treatment, but for all the years after treatment the point-estimates indicate a positive and increasing impact on working hours. According to the point-estimates, the full-time equivalent increased by 7 percentage points three years after the implementation of CWS, with confidence intervals ranging from a reduction of 2 percentage points to an increase of 14 percentage points.

Our results add to a research literature dominated by cross-sectional studies with subjective measures of sickness absence. Although recent developments have seen an increased emphasis on using longitudinal register data to investigate this relationship, these studies are few and mixed in their findings (Ropponen et al., 2019; Vedaa et al., 2019a; Dall'Ora et al., 2019, Larsen et al., 2020; Rodriguez Santana et al., 2020). Two of the studies (Vedaa et al., 2019a; Peutere et al., 2021) found that extended shifts were associated with lower sickness absence while the others found that extended shifts were associated with higher sickness absence. The studies were based on data from mental health hospital (Rodriguez Santana et al., 2020) and ordinary hospital units (Ropponen et al., 2019; Vedaa et al., 2019a; Dall'Ora et al., 2019, Larsen et al., 2020). One of the studies (Rodriguez Santana et al., 2020) followed units before and after introduction of extended shifts. They utilize a causal inference design (Difference-in-Difference design and Interrupted Time Series) to identify how extended shifts affect short-term sickness absence (measured as sickness absence up to 7 days). Their study was based on six patient inwards within a mental health hospital in England where extended shifts (from 8 to 12 hours) was introduced between June and October 2017. The authors took advantage of differential timing in the implementation of extended shifts using not-yet-treated wards as controls for the wards who first introduced extended shifts. The wards were observed on weekly basis during 2016-2018 resulting in 463 observations. Their results showed a significant increase in absence hours per week of between 0.73% and 0.98% after implementation. Our study is not directly comparable with their study and there may be several reasons why our results differ. First, we use a different methodology as we can include information on a set of never-treated units, which Rodriguez-Santana et al. (2020) cannot. Second, their analysis focuses on short-term sickness absence (1-7 days) only, while our data covers certified sickness absence spells potentially lasting up to one year. Different results could also be related to different samples; they are studying mental hospital wards while we focus on workplaces within the municipalities' health- and care sector.

Previous literature is sparse when it comes to evidence regarding extended shifts and turnover, but there are some studies investigating nurses' intention to quit (Dall'Ora et al., 2022). According to a survey of 52,000 hospital nurses in four states in US, nurses working extended shifts were more likely to report intentions to leave the job (Stimpfel et al., 2012). Similar results were found in a cross-sectional survey of 32,000 hospital nurses across 12 European countries (Dall'Ora et al., 2015). As these are cross-sectional studies the associations may, however, be related to selection effects where nurses with higher intention to quit may be more likely to choose to work extended shifts (Dall'Ora et al., 2022). Our results do not indicate higher turnover due to CWS. We do not find any evidence of lower turnover either, which for many employers is one of the intentions behind implementing CWS.

In line with the intention, we find that CWS has a positive effect on working hours. Our point estimate shows that working hours increased by 5.8% after the introduction of CWS. We are not aware of other studies using such a large sample of establishments to investigate the effect of CWS on working hours. In recent years the health and care sector in Norway has focused on developing a full-time culture (KS, 2021) to meet the sector's steadily increasing labor demand. An implication of this is the desire to promote scheduling practices that promote and facilitate full-time work (KS, 2021). Our results suggest that the effect of CWS on working hours is only modest. It may illustrate that the reasons behind the high share of part-time work in this sector is complex and goes beyond shift scheduling practices. However, we are not able to rule out that the process towards a full-time culture might materialize over a longer time period than we consider in this paper.

To the best of our knowledge, this study is the first to investigate how CWS affects several important labor market outcomes within a single context. This is important to give a broader overview of the impact of changes and because different outcomes may interact. For example, it may be a trade-off between working hours and sickness absence as an increase in working hours means less time for restitution implying an adverse effect on health and sickness absence. On the other hand, part-time work, in itself, may increase workload for employees because part-time workers are less often at work and have to spend more time updating themselves. Extensive use of part-time work in an establishment can also affect all employees in the establishment because of less continuity and more responsibility for those working full-time. Furthermore, part-time work can lead to financial insecurity for the individual, which in turn may affect health and sickness absence. However, our results do not indicate a trade-off between working hours and sickness absence. We do not find any support for a reinforcing effect either.[16]

Although our point-estimates for sickness absence and turnover are relatively precisely estimated to zero, we cannot rule out that CWS have heterogeneous effects for sickness absence or turnover.[17] For example, it might be that the effect varies between types of services (nursing homes, home-based care and various types of assisted living facilities) due to e.g different working tasks, composition of patients, varying workload and opportunity to take breaks during the workday. Another important factor might be the degree of autonomy to choose shift patterns, which have been found to reduce sickness absence among employees (Turunen et al., 2020). On the other hand, findings from Ingstad & Amble (2015) suggest that the positive impact of CWS (reduced stress due to e.g increased continuity and freedom to prioritize tasks) occurs primarily when all employees within a unit work extended shifts.

5.2 Robustness analyses

In this section we first investigate whether the results affect the composition of staff, which in turn may affect our outcome measures. Second, we explore whether the results are sensitive to sample selection criteria. Finally, we include an alternative measure of turnover, namely the share of workers quitting the job.

In Figure 3, we show how CWS influences the composition of staff measured as the share with relevant education (Panel A), the average age of staff (Panel B) and the share of female workers

[16] Previous studies have found both positive and negative associations between working hours and sickness absence (Bernstrøm & Houkes, 2018)

[17] In the analysis plan we include analysis capturing heterogeneous effects. Due to limited power this, however, was not possible.

(Panel C). These variables are relevant as changes in staff composition might predict sickness absence and turnover. We find an increase in the share of employees with relevant education for establishments that change to CWS, but this effect is not significant.[18] In terms of mean age, the effect fluctuates around zero over the analytical window, and none of the period-specific effects estimated are significant. Finally, we find suggestive evidence of a drop in the share of female workers, which seems to be persistent and grow in magnitude, but the effect is also not significant. As with the main effects displayed in Figure 3, we see that the estimates for the third year are estimated imprecisely due to the small sample of establishments that changed to CWS in the first year of observations. Overall, there seem to be some changes in the composition of staff as measured by a higher share with relevant education and a reduced number of females. However, we are hesitant to draw strong conclusions based on this analysis.

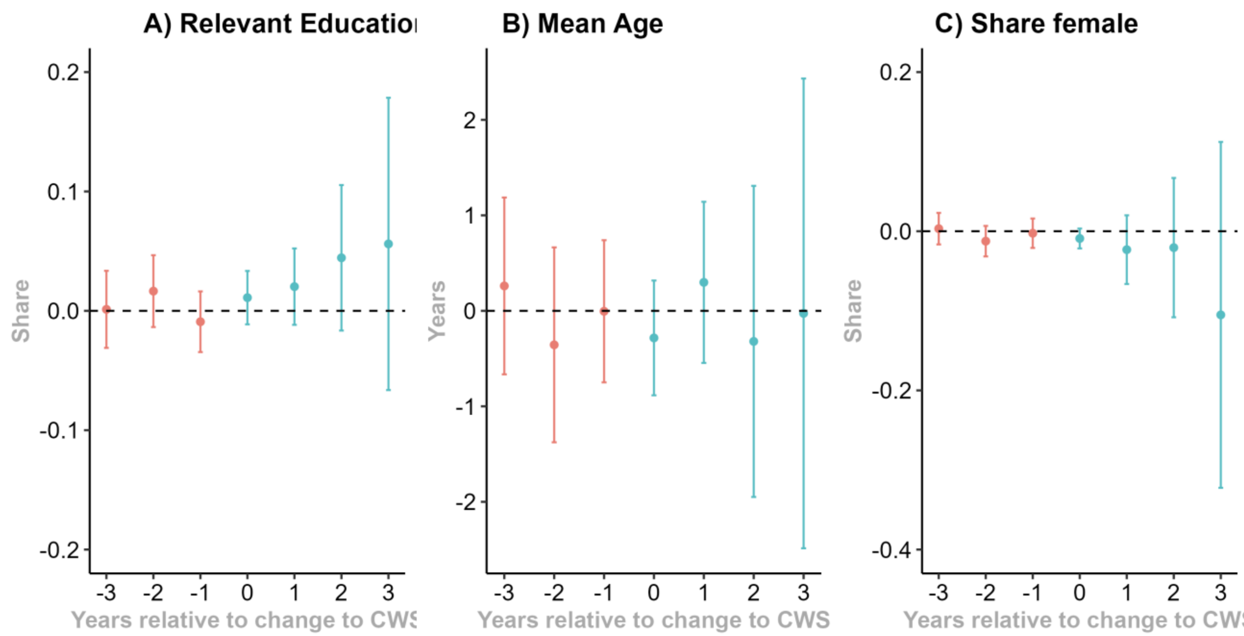

Figure 3. Event study estimates on staff composition

Notes: This figure presents event study estimates of the effect of CWS on share of health- and social care professionals as measured by relevant education, mean age and share of female workers. The model is estimated using the Callaway and Sant'Anna (2021) DiD estimator as described in Section 4 at the establishment level. Change to CWS is defined in Section 2. ATT`s are estimated for each period using varying base period. The figure shows bootstrapped 95% simultaneous confidence intervals. Sampling weights employed and standard errors are clustered at the panel (establishment) level. Capped spikes represent 95% confidence intervals. Relevant education is measured as health and social care professionals with either a diploma, bachelor's or master's degree (see Table A.6). The exact point estimates and confidence intervals are provided in table A10-A12.

[18] The sign of the point-estimate is in line with one of the intention of introducing CWS, namely to attract more qualified staff.

We report the results from our other robustness checks in Table 4. First, we extend the sample to include *all* establishments introducing CWS during the period 2019-2022, including those that first implemented extended shifts during weekends only. When these establishments are included in the sample, all effects are estimated with greater precision (due to the increase in sample size). The point estimate for sickness absence indicates a small increase, but the effect is nevertheless far from being significant. Point estimates for the effects on turnover and working hours remain virtually unchanged, but the estimated effect on working hours is significant at the 1% level.

In our second check, we revert to our preferred sample of establishments, but restrict the sample of workers included in the analysis to those aged 25-66 and holding at least a 50% position. The last restriction is commonly used within the literature investigating the impact of extended shifts on sickness absence (e.g. Vedaa et al., 2019a; Garde et al., 2019). With this restriction we narrow the sample to employees with more stable employment relationships. Hence, we exclude many students, pensioners and others for whom employment is not their main activity. Using this sample, we find a point estimate suggesting that CWS reduces sickness absence by 0.2 calendar days, but the estimate is not significant. Likewise, we still find null effects for turnover. According to the point estimates, the average full-time equivalent increases by 2.0 percentage points, which is a substantially smaller effect compared to the main results. On the other hand, the effect on working hours is now more precisely estimated and significant at the 1% level.

For our third check, we also include employees who do not work shift in the analysis. These employees are not directly affected by changes in the work schedules, but there may be spillover effects from the treated workers. For example, CWS may affect the working environment which again may influence the whole group of employees measured by sickness absence. However, as expected, the estimated effects on sickness absence and turnover are still zero. The point-estimates of CWS on working hours are now lower in magnitude and not significant at any level.

In our final robustness analyses, we also include an alternative measure of turnover. Our main definition of turnover is not able to distinguish between workers who quit and new workers. Hence, we may not capture whether CWS influence employees' likelihood of quitting, an important marker of job satisfaction in its own right. To explore this, we include an alternative measure of turnover, defined as the share of workers who quit during a year. This measure is also comparable to previous literature on turnover, measuring intention to quit using survey data (Stimpfel et al., 2012; Dall'Ora et al., 2015). According to our estimates, this way of defining turnover does not seem to affect our results.

Table 5. Estimated effect of CWS on sickness absence, turnover and working hours – alternative models (standard errors in parentheses)

	(1) Sickness absence	(2) Turnover	(3) Share quit	(4) Work-hours
Main model/sample (from Table 4; N=1,068 establishments (4,474 observations), 70 treated establishments, 240,641 employment records)	*-0.011 (0.226)* *[-0.454 0.433]*	*-0.001 (0.016)* *[-0.033 0.030]*	*0.011 (0.021)* *[-0.030 0.052]*	*3.493 (1.228)** *[0.985 6.0043]*
1.Extended sample of establishments				
Include all establishment implementing CWS, also those first introducing extended shifts during weekends only *(N=1,133 establishments (4,792 observations), 135 treated establishments, 261,066 employment records)*	0.080 (0.179) [-0.272 0.431]	0.004 (0.013) [-0.030 0.020]	0.005 (0.014) [-0.023 0.033]	3.543 (1.001)*** [0.959 6.127]
2.Reduced sample of individuals				
Employees 25-66 years and holding at least a 50% position *(Same sample as the main model regarding establishments. Reduced sample of employment records (145,400)*	-0.211 (0.405) [-1.005 0.584]	0.007 (0.019) [-0.044 0.031]	0.003 (0.019) [-0.034 0.033]	1.973 (0.676)*** [0.648 3.298]
3.Extended sample of individuals Employees not registered with shift work is also included. (*Same sample as the main model regarding establishments. Increased sample of employment records (290,950), same sample of establishments as in the main sample)*	-0.040 (0.233) [-0.496 0.416]	0.004 (0.015) [-0.025 0.033]	0.006 (0.017) [-0.029 0.039]	3.133 (1.659) [-0.120 6.387]

Note: This table presents Difference-in-Difference (DiD) estimates of the effect of changing to CWS on three alternative samples, using the same outcomes as in the main estimation and another outcome called share quit from one year to the next. All models are estimated using the Callaway and Sant'Anna (2021) DiD estimator using the dynamic aggregation. All panels present the aggregated ATT across all time-periods. All results are obtained from estimating the sample analogue of equation (3). *** p<0.01; ** p<0.05; *p<0.10

6 Conclusion

In this paper we have investigated how working fewer but longer shifts in compressed work schedules (CWS) in the context of municipal health and care services impact sickness absence, turnover and contracted working hours for the employees. We find no effect of introducing CWS on sickness absence or turnover. There is however a positive and increasing impact on contracted working hours, which increased by 5.8% over a three-year period.

Taken together, our results indicate that CWS may have a positive impact on some measures of efficiency in the health- and care sector. In particular, we find suggestive evidence that contracted working hours might increase with this scheduling policy, without adverse effects on sickness absence and turnover. In a sector dominated by part-time employment, such an effect is likely to be viewed favorably by policymakers and other stakeholders. By increasing work hours per employer, health care providers might need fewer employees to fill the same number of full-time equivalents. An increase in working hours will also likely be beneficial for patients as more full-time staff could lead to increases in the continuity of care. In addition, employees benefit in terms of higher earnings and pensions.

This study has some limitations. First, the information about CWS is measured at the establishment level, meaning we do not have information about which and how many employees work extended shifts. This also means that we run analyses on the establishment level only and not at the individual level. Hence, we are not able to estimate long- run effects for the individuals. However, we have information about the type of work schedules for a large group of establishments covering thousands of employees. Second, although the sample size of establishments in the survey is large, covering a large share of workplaces within the health- and care sector, the number of treated units is limited, leading to large standard errors in some cases. In particular, the precision of our analysis prevents us from more thorough investigations into how the effects of CWS might differ across various groups of workers and establishment. Third, although the recency of our data is beneficial for the relevance and external validity of our analysis, it prevents us from investigating longer-term effects, which will be an important focus for future studies.

We do not, however, have information about overall efficiency of implementation of CWS. Further research is needed to provide a more complete overview of costs and benefits. For example, we do not have information about staffing costs and quality of care.

Both sickness absence, turnover and working hours are important measures of efficiency in the health and care sector. Is it possible to introduce a work schedule being beneficial for all these outcomes? More research is needed on how these variables interact to find ways to organize work schedules being beneficial for all these outcome

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Appendix

Table A1. Definition of sample constructed for Table 1

Description	Excluding	Sample (n)
All employment records registered in A-ordningen as of May 2018-2022		4,895,490
Zero or negative earnings («kontantlønn»)	(-)1,968,623	2,926,867
Not registered with an employer	(-) 1,891	2,924,976
Employment records not counted as «normal»	(-) 146,935	2,778,041
No information about contracted working hours (arb_arbeidstid ne ‘’)	(-) 25,408	2,752,633
Not employed the whole month (May)	(-) 24,592	2,728,041
Not within the age 20-70	(-) 127,108	2,600,933

Table A2. Processing data from the survey

Action	Add/remove	Sample size (establishments)
Survey end		1,587
Remove answers not consenting	(-)40	1,547
Duplicates (i.e. managers answering for several establishments)	(+)15	1,562
Remove establishments answering “don’t know” or blank to all questions about organizing work schedules	(-)6	1,556
Remove establishments stating they do not have shift work	(-)15	1,541
Aggregate (i.e. keep only one answer when establishments have provided more than one answer)	(-)111	1,430
Remove establishments with missing link to register.	(-)3	1,427

Table A3. Overview of central questions in the establishment survey

1	**The first question relates to how the establishment has organized the workday. We ask about different types of work schedules:** **Two-shift rotation**: The 24-hour day is divided into three, where some employees rotate between working day and evening, while other employees permanently work night shifts, **Three-shift rotation**: The 24-hour day is divided into three, and the employees rotate between working day, evening and night shifts, **Extended shifts**: shifts lasting more than 10 hours are included in the employees' work schedule implying that workers have longer but fewer shifts. Extended shifts can be used throughout the week or just at weekends. We do ***not*** mean long work sessions that arise due to special needs or that employees sometimes work double shifts. Also, we do not mean co-liver shifts. **24-hour shifts**: a shift schedule where employees work for 24 hours or more, where the shift includes active work and resting work. Which of the following shift schedules has your establishment had in the last four years? (Several answers are possible. Check the years the establishment had each of the shift schedules, also if only a small group of employees had that type of shift schedule). Provide status by May 1 each year.

	Two-shift rotation	Three-shift rotation	Extended shifts	24-hour shifts	Other	Don't know
May 1 2022						
May 1 2021						
May 1 2020						
May 1 2019						
May 1 2018						

2 We now wonder whether the employees worked extended shifts **all weekdays** or only had extended shifts during **weekends** (for instance by working extended shifts on Saturdays and Sundays).
When did employees work extended shifts during a work week? (Several alternatives are possible). Provide status per May 1 each year.[19]

	All weekdays	Only during weekends	Other	Don't know
May 1 2022				
May 1 2021				
May 1 2020				
May 1 2019				
May 1 2018				

Table A4. Descriptive statistics of establishments reporting extended shifts. May 2022

Number of establishments	*615*
Type of service (%)	
Nursing homes	22.3
Home-based services	17.7
Assisted living facilities for people with intellectual disabilities	31.4
Assisted living facilities for elderly and people with functional disabilities	28.6
Combination with other types of work schedules (%)	
Extended shifts only	14.0
Two-shift schedule	84.6
Three-shift schedule	21.8
24 h shifts	7.0
Length of extended shifts (hours) (%)	
10-11.5	3.6
12	20.6
12.5	49.0
13-14.5	26.1
15-23	1.6
When employees worked extended shifts (%)	
All weekdays	28.3
Only during weekends	55.1

[19] This is a follow-up question asked to respondents reported having or having had extended shifts in the previous question.

Combination of all weekdays and weekends only	10.1
Other	5.9
Extended shifts on days and/or night shifts (%)	
Dayshift	98.4
Nightshift	27.1
Frequency of weekends (several answers possible) (%)	
Every second	3.9
Every third	25.9
Every fourth	73.2
Every fifth	2.4
Every sixth	7.3

Table A5. Definition of sample constructed for descriptive statistics survey population

Description	**Excluding**	**Sample (n)**
All employment records covered by the survey population and registered in A-ordningen as of May 2018-2022		572,653
Zero or negative earnings	(-) 134,748	437,905
Not registered with an employer	(-) 0	437,905
Employment records not counted as «normal”[20]	(-) 11,198	426,707
No information about contracted working hours	(-) 3,128	423,579
Not employed the whole month (May)	2,989	420,590
Not within the age 20-70	12,961	407,629
Not shift-work	52,444	355,185
No answer regarding the type of work schedule	8,610	346,575

Table A6. Definition of variables

Group of health- and social care professional	**Classification of education (NUS)***	**Main groups of professionals**
Health and social care professionals with (at least) bachelor degree	661, 662, 663, 665, 669, 761, 762, 763, 765, 769, 861, 862, 863, 865, 869,	Nurses
Health and social care professionals with diploma	461, 462, 463, 465, 561, 562, 563, 565, 569, 361201, 361202, 469901, 469910	Auxillary nurses
Employees without formal health and social care edcuation	Rest	

Note: *For a description of classification of education (NUS), see https://www.ssb.no/klass/klassifikasjoner/36

[20] See Statistics Norway, 2024

Table A7. Estimates of the effect of change to CWS on sickness absence – Event estimates

Event time	Estimate	Std. Error	[95% Simult.	Conf. Band]
-3	-0.154	0.311	-0.926	0.619
-2	0.071	0.265	-0.589	0.731
-1	0.116	0.236	-0.471	0.703
0	-0.024	0.221	-0.574	0.527
1	-0.166	0.201	-0.666	0.334
2	-0.153	0.332	-0.978	0.674
3	0.300	0.574,	-1.128	1.727
Observations (Year*Establishments)	4,474			

Table A8 : Estimates of the effect of change to CWS on turnover – Event estimates

Event time	Estimate	Std. Error	[95% Simult.	Conf. Band]
-3	0.008	0.015	-0.027	0.043
-2	0.019	0.018	-0.024	0.063
-1	-0.003	0.017	-0.044	0.039
0	0.015	0.014	-0.018	0.047
1	-0.006	0.019	-0.051	0.039
2	-0.041	0.027	-0.105	0.023
3	0.026	0.039	-0.068	0.119
Observations (Year*Establishments)	4,474			

Table A9 : Estimates of the effect of change to CWS on work hours – Event estimates

Event time	Estimate	Std. Error	[95% Simult.	Conf. Band]
-3	-0.314	0.629	-1.846	1.217
-2	1.506	0.856	-0.581	3.593
-1	0.254	0.674	-1.388	1.896
0	1.234	0.806	-0.731	3.198
1	2.844	1.223	-0.136	5.823
2	3.230	1.836	-1.245	7.705
3	6.670	3.111	-0.912	14.252
Observations (Year*Establishments)	4,474			

Table A10 : Estimates of the effect of change to CWS on mean age – Event estimates

Event time	Estimate	Std. Error	[95% Simult.	Conf. Band]
-3	-0.267	0.360	-0.6213	1.143
-2	-0.356	0.457	-1.477	0.764
-1	-0.004	0.282	-0.696	0.686

0	-0.284	0.229	-0.845	0.278
1	0.298	0.359	-0.582	1.178
2	-0.320	0.617	-1.832	1.191
3	0.027	1.042	-2.579	2.252
Observations (Year*Establishments)	4,474			

Table A11 : Estimates of the effect of change to CWS on share of feamle – Event estimates

Event time	Estimate	Std. Error	[95% Simult.	Conf. Band]
-3	0.033	0.009	-0.019	0.025
-2	-0.013	0.009	-0.033	0.008
-1	-0.0002	0.008	-0.021	0.016
0	-0.009	0.006	-0.022	0.004
1	-0.023	0.019	-0.067	0.021
2	-0.020	0.038	-0.107	0.066
3	-0.105	0.098	-0.326	0.116
Observations (Year*Establishments)	4,474			

Table A.12 : Estimates of the effect of change to CWS on share of relevant education – Event estimates

Event time	Estimate	Std. Error	[95% Simult.	Conf. Band]
-3	0.001	0.011	-0.027	0.029
-2	0.017	0.012	-0.014	0.047
-1	-0.009	0.011	-0.037	0.019
0	0.011	0.010	-0.013	0.035
1	0.020	0.013	-0.012	0.052
2	0.044	0.026	-0.021	0.110
3	0.056	0.044	-0.054	0.166
Observations (Year*Establishments)	4,474			