

ORIGINAL ARTICLE

Incidence rates of occupational contact dermatitis in Denmark between 2007 and 2018: A population-based study

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Abstract

Background: Recent population-based studies on the incidence rates (IRs) of occupational contact dermatitis (OCD) are sparse.

Objectives: To determine the IRs of OCD and development thereof between 2007 and 2018 in known risk occupations.

Methods: Data on all recognized cases of OCD were used to calculate IRs as the number of recognized OCD cases per 10 000 workers per year. Asymptotic chi-square test was used to compare the IRs between 2007-2012 and 2013-2018.

Results: The median age at notification of OCD was below 30 years for several of the examined occupations. Hairdressers and beauticians, bakers, dentists and dental assistants, and manufacturing of windmills had the highest overall IRs of OCD. We found a statistically significant increase in the IRs of OCD for child/nursery care workers.

Conclusions: The median age at notification of OCD was low for several of the occupations, signifying the need for further preventive strategies among young people. Based on the IRs of OCD, future preventive efforts should be directed at hairdressers and beauticians, bakers, dentists and dental assistants, and manufacturing of windmills. Furthermore, the statistically significant increase in IRs of OCD among child/nursery care workers highlights the need for further preventive strategies in this field.

KEYWORDS

contact dermatitis, epidemiology, incidence rate, occupational, population-based study, trend in incidence rates

1 | INTRODUCTION

Occupational contact dermatitis (OCD) is the most frequently recognized occupational disease in many Western countries including Denmark, and constituted one-third of all recognized occupational diseases in Denmark in 2019.¹ The consequences of OCD for the affected individual are substantial with decreased quality of life,² job loss or unemployment,³ and loss of income.⁴ The Danish Labour

Market Insurance (DLMI) uses approximately €23 million per year on compensation for permanent injury and reduction in earning capacity to afflicted workers with OCD alone, making OCD one of the most expensive occupational diseases in the DLMI system.¹

Recent population-based epidemiological studies on the incidence rates (IRs) of OCD are sparse. To be able to target the prevention effort on the areas where it will have impact, recent data on the development in IRs of OCD within the known at-risk occupations are

warranted. The aim of this study is to investigate the trends in IRs of OCD in different occupational fields over a 12-year period, and the differences regarding age at recognition and gender. Detailed knowledge about the development of IRs of OCD in the known at-risk occupations may help to focus preventive measures directed at OCD.

2 | METHODS

2.1 | Data from the Danish Labour Market Insurance Register

The DLMI is the official entity for notification and recognition of occupational diseases in Denmark and is furthermore responsible for the granting of economic compensation to afflicted workers. The criteria for recognition of contact dermatitis as occupational in Denmark are typical symptoms, a relevant exposure at the workplace, and a relationship in time between the exposure and the onset or worsening of the contact dermatitis. The DLMI provided data on all cases of recognized OCD in Denmark between 1 January 2007 and 31 December 2018. The data included gender, age at onset, dates of notification and recognition, diagnosis (irritant or allergic contact dermatitis), and occupation. Some workers occurred several times in the register, and to avoid duplicates, workers with both a recognized occupational irritant contact dermatitis and a recognized occupational allergic contact dermatitis were coded as having an occupational allergic contact dermatitis.

2.2 | Data from statistics Denmark

Data on the number of employees between 2007 and 2018 in the different occupations were delivered by Statistics Denmark. We chose to include both part- and full-time employees in the analysis.

2.3 | Occupations

The occupations registered in the DLMI registry and at Statistics Denmark were based on the Danish Industry Code year 2007 (DB07). The DB07 is based on the industry of the workers' place of employment, but for the purpose of this study, we used the DB07 as an indicator of the workers' occupation, that is, a worker registered with the DB07 code corresponding to "Cleaning within buildings" was translated as a worker having the occupation *Cleaning personnel*. Occupations with similar activities were grouped together. In order to evaluate the most afflicted occupations, the following criteria were used when choosing which occupations to focus on in this study: ≥ 90 recognized cases between 1 January 2007 and 31 December 2018, ≥ 5000 part- and full-time employees in Denmark on average between 2007 and 2018, and overall IR in 2007-2018 ≥ 4.0 per 10 000 workers per year. Among the

occupations that met the aforementioned criteria were "General public services" and "Administration of healthcare, education, culture and social relations except social security." These two occupations were left out of the further analysis, as it is not clear which occupations are entailed in these. This resulted in 28 occupations that were selected for further examination in this study. Among these, two occupations require further explanation, namely, "Vocational school," which includes both teachers and students in schools focusing on craftsmanships, such as hairdressing, plumbing, flower binding, medical assistants, and more, and "Retail sale of cars, vans, and minibuses" that most likely includes auto mechanics working in auto repair shops affiliated with the car dealership.

2.4 | Data analysis and statistics

Statistical analyses were performed in SPSS version 24 (IBM, New York, New York). The IRs were defined and calculated as the number of recognized OCD cases per 10 000 workers per year. In order to examine any development in the IR, we divided the study period into two separate study periods: 2007-2012 (1 January 2007 to 31 December 2012) and 2013-2018 (1 January 2013 to 31 December 2018). We assumed constant IRs within the two study periods. Asymptotic chi-square test was then used to compare the IRs between 2007-2012 and 2013-2018. All *P*-values are two sided, and a 5% level of statistical significance was used.

2.5 | Data permissions

The study was approved by the Danish Data Protection Board (no. HGH-2017-093, I-suite no. 05911).

3 | RESULTS

3.1 | Characterization of the study population

The study population consisted of all recognized cases of OCD between 1 January 2007 and 31 December 2018 ($n = 16\,484$). The characteristics of the study population are presented in Table 1. As described in the "Methods" section, 28 occupations were selected for further examination in this study. Workers employed in one of these 28 occupations were chosen for analysis and comprised 62% of the total cohort ($n = 10\,235$). The distribution of gender, age, and diagnosis was comparable in the total cohort and the analysed cohort of the 28 occupations. In the analysed cohort of the 28 occupations, the female-to-male ratio was approximately 2:1, the mean age at notification was 36.3 years (median 34; quartiles 25-47): 36.2 years for women (median 34; quartiles 25-46.5) and 36.7 years for men (median 35; quartiles 25-47). About 71.6% were diagnosed with irritant contact dermatitis, and 28.4% were diagnosed with allergic contact dermatitis.

TABLE 1 Characteristics of the study population: workers with recognized occupational contact dermatitis between 1 January 2007 and 31 December 2018—Data are presented for both the total cohort (n = 16 484) and the analysed cohort of workers employed in one of the 28 occupations chosen for examination in this study (n = 10 235)

Characteristics	Total cohort (all occupations) (n = 16 484)	Analysed cohort (28 occupations) (n = 10 235)
Male, n (%)	5374 (32.6)	3146 (30.7)
Female, n (%)	11 110 (67.4)	7089 (69.3)
Age (years), mean ± standard deviation	37.6 ± 12.8	36.3 ± 12.8
Allergic contact dermatitis, n (%)	4698 (28.5)	2903 (28.4)
Irritant contact dermatitis, n (%)	11 786 (71.5)	7332 (71.6)

3.2 | Overall incidence rates

The overall IRs of OCD within the 28 occupations for the period 2007–2018 was 9.8 per 10 000 workers per year. The overall IRs per 10 000 workers per year for the 28 most afflicted occupations are listed in the decreasing order of their overall IR in Table 2. Following the classification used by Dickel et al⁵ we found 17 occupations to be exceedingly high-risk (IR of OCD ≥ 7 cases per 10 000 workers per year), and 11 occupations to be high-risk occupations (IR of OCD 3–7 cases per 10 000 workers per year). The highest IRs were found among hairdressers and beauticians (IR 42.5 per 10 000 workers per year), bakers (IR 26.5 per 10 000 workers per year), dentists and dental assistants (IR 18.0 per 10 000 workers per year), and manufacturing of windmills (IR 17.5 per 10 000 workers per year).

3.3 | Difference in incidence rates between 2007–2012 and 2013–2018

We found a significant decline ($P < .001$) in the IRs of OCD within the 28 occupations: 10.1 per 10 000 workers per year for the period 2007–2012 and 9.5 per 10 000 workers per year for the period 2013–2018. In Figure 1A,B, the 28 most afflicted occupations are listed with their IRs for each study period in the decreasing order of their overall IR. A figure illustrating the difference in IRs of OCD between the two study periods can be found in the Supporting information (Figure S1). The decline in IRs of OCD between the two periods was statistically significant for hairdressers and beauticians (51.8–33.4 per year per 10 000 workers, $P < .001$), manufacturing of windmills (22.4–13.2 per year per 10 000 workers, $P < .001$), bakers (30.1–22.4 per year per 10 000 workers, $P = .009$), production of plastic (9.7–5.4 per year per 10 000 workers, $P = .002$), hotel workers (12.0–8.4 per year per 10 000 workers, $P = .025$), postal workers (6.7–3.9 per year per 10 000 workers, $P = .013$), and metalworkers other than machining (9.0–7.5 per year per 10 000 workers, $P = .014$). We

only found a statistically significant increase in IRs of OCD between the two study periods among child/nursery care workers (3.6–5.8 per year per 10 000 workers, $P < .001$).

3.4 | Distribution of gender and age within the 28 occupations

The distribution of gender and the mean age at notification of the OCD within the 28 occupations are listed in Table 3 in the increasing order of the mean age at notification of the OCD.

The median age at notification was lowest among the following workers: bakers (24 years); vocational schools (24.5 years); hairdressers and beauticians (25 years); restaurant workers (25 years); hotel workers (25 years); retail sale of cars, vans, and minibuses (25 years); breeding of pigs and dairy cattle (25 years), and auto mechanics (26 years), whereas the median age at notification was highest among the following workers: postal workers (48 years), production of plastic (44 years), production of pharmaceuticals (43 years), metalworkers other than machining (42 years), food production (41 years), and home care workers (41 years).

Of the female cases nearly 58.8% occurred in hospital workers (22.7%), nursing home workers (17.2%), hairdressers and beauticians (10.2%), and restaurant workers (8.7%), whereas 43.7% of the male cases occurred in the following cases: metalworkers (machining metalworkers and metalworkers other than machining; 24.1%), mechanics (auto mechanics; mechanics other than auto mechanics; and retail sale of cars, vans, and minibuses; 13.2%), restaurant workers (10.8%), and manufacturing of windmills' workers (6.5%).

4 | DISCUSSION

4.1 | The overall tendencies in occupational contact dermatitis incidence rates

We found an overall IR within the 28 occupations of 9.8 per 10 000 workers per year (2007–2018). It is difficult to compare studies examining the IRs of OCD in different countries, as there are differences with regard to the definition of the diagnoses, medical examination methods, recognition criteria, and the quality of the registries, but considering all this, due to a similar reporting system, our findings are comparable to earlier estimations of IRs around 7 per 10 000 workers per year in Germany,^{5,6} and the systematic review by Diepgen and Coenraads,⁷ who found the IR of occupational skin diseases (whereof the large majority was OCD) to be 5 to 19 new cases per 10 000 full-time workers per year, based on collected data in different Western industrial countries.

All the chosen 28 occupations in our study were identified as either exceedingly high-risk or high-risk occupations based on the calculated IRs. Similar occupations were found to be risk occupations by Aalto-Korte et al⁸ who examined a similar data set from Finland for the period 2005–2016.

TABLE 2 Overall incidence rates of occupational contact dermatitis (per year per 10 000 workers) for the 28 most afflicted occupations listed in the decreasing order of their overall incidence rate

Occupation	Number of OCD cases between 2007 and 2018	Number of employees in Denmark ^a	Overall IR of OCD during 2007-2018 (per 10 000 workers per year)
Hairdressers and beauticians	734	14 381	42.5
Bakers	325	10 221	26.5
Dentists and dental assistants	339	15 654	18.0
Manufacturing of windmills	250	11 897	17.5
Butchers and slaughterhouse workers	232	13 619	14.2
Nursing home workers	1262	74 539	14.1
Hospital workers	1750	114 007	12.8
Machining metalworkers	102	7253	11.7
Cleaning personnel	469	35 108	11.1
Painters	156	12 052	10.8
Restaurant workers	955	73 951	10.8
Hotel workers	163	13 362	10.2
Metalworkers other than machining	819	82 129	8.3
Auto mechanics	131	13 218	8.3
Production of plastic	127	13 633	7.8
Food production	271	29 560	7.6
Retail sale of cars, vans, and minibuses	179	20 148	7.4
Residential institutions for people with disabilities	276	39 007	5.9
Home care workers	282	40 802	5.8
Postal workers	105	15 512	5.6
Supermarket employees	184	27 502	5.6
Breeding of pigs and dairy cattle	125	18 841	5.5
Builders	82	12 397	5.5
Vocational schools	140	22 085	5.3
Mechanics other than auto mechanics	137	22 158	5.2
Child/nursery care workers	441	78 870	4.7
Plumbers	97	17 852	4.5
Production of pharmaceuticals	102	20 399	4.2
Total (within all 28 occupations)	10 235	870 156	9.8

Abbreviations: IR, incidence rate; OCD, occupational contact dermatitis.

^aInformation obtained from Statistics Denmark December 2020, and includes the average number of employees during 2007-2018.

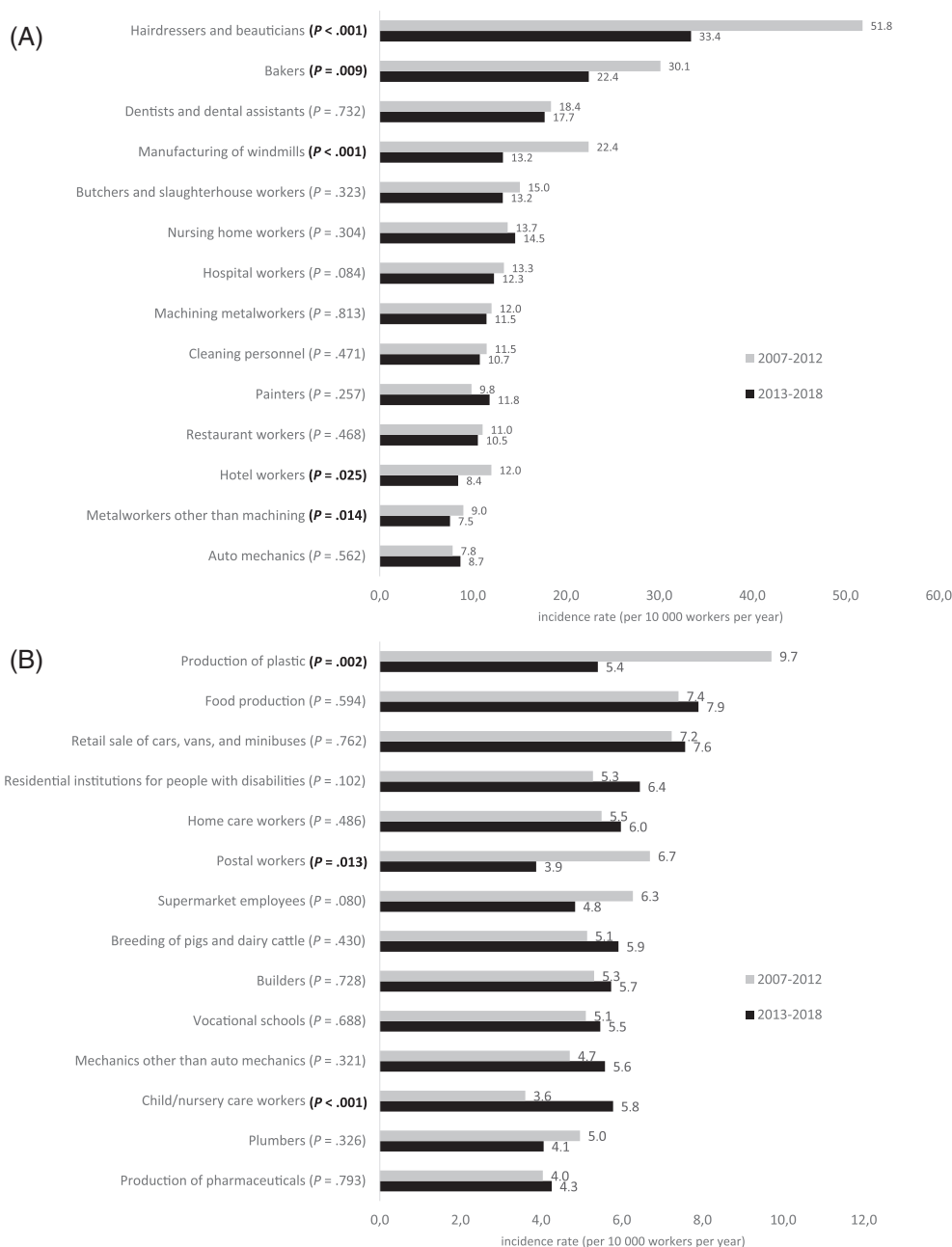
The IRs reported in this study are most likely an underestimation of the actual OCD frequency, due to underdiagnosing and underreporting of OCD. Studies have found that only 12% of hand eczema cases among healthcare workers and 20% of hand eczema cases among hairdressers were reported to the Danish National Board of Industrial Injuries Register (the earlier DLMI) as having occupational hand eczema.^{9,10}

We found a statistically significant ($P < .001$) decrease in the IR of OCD for the 28 occupations from 10.1 per 10 000 worker per year in 2007-2012 to 9.5 per 10 000 worker per year in 2013-2018, corresponding to a decrease of approximately 6%. Although positive, this decrease is not impressive, and the lack of real change in this area is a reflection of the missing attention and focus from the working environment authorities within the last 10 years.

4.2 | Occupational contact dermatitis and young people

We found the median age at notification to be in the early to mid-twenties for several of the examined occupations (ie, bakers, vocational schools, hairdressers and beauticians, restaurant workers, mechanics among others), stressing the fact that it is young people just in the beginning of the career of their choosing that are afflicted by OCD. This corresponds to the findings by Uter et al¹¹ that the IR of occupational skin disorders among hairdressing apprentices is highest within the first 3 years of training, and the results found in a German cohort study that 29% of apprentice bakers suffer from hand dermatitis within 6 months of commencing training.¹² Considering the

FIGURE 1 (A,B) incidence rates of occupational contact dermatitis within the 28 most afflicted occupations in the two study periods (2007-2012 vs 2013-2018) listed in decreasing order of their overall incidence rate. Statistically significant *P*-values are marked in bold. A different scale is used in panels



grave consequences of OCD on work life, income, and quality of life of the individual, these are very concerning facts.²⁻⁴

4.3 | Occupational contact dermatitis among hairdressers and beauticians

The highest overall IR was found not surprisingly among hairdressers and beauticians (overall IR 42.5 per 10 000 workers per year). This occupational field is known to have a high risk for the development of OCD, with high IRs of hand dermatitis.^{11,13} The IR of OCD for hairdressers and beauticians found in this study is comparable to the annual IR of 48.2 per 10 000 workers found in Saarland, Germany,⁶ and the IR of 56.1 per 10 000 workers per year reported in a Danish

study examining the IR of recognized OCD in different occupations between 2001 and 2002.¹⁴ We observed a statistically significant decrease in IR of OCD between 2007-2012 and 2013-2018 from 51.8 to 33.2 per 10 000 per year, corresponding to a reduction of approximately 35%. These results are in line with the findings in a not yet published study by Havmose et al¹⁵ who detected that the lifetime prevalence of hand eczema among Danish hairdressers has decreased significantly from 45.1% to 39.1% for hairdressers certified in 1997-2007 and 2008-2018, respectively. One reason for this decrease could be the implementation of a nationwide prevention program in all hairdressing schools in Denmark in 2011, based on the positive results from an earlier intervention study.¹⁶ Although we found a significant decrease in IR among hairdressers in the observed period, this is still a field that needs substantial attention with regard

TABLE 3 Distribution of gender and the median age at notification of the occupational contact dermatitis within the 28 most afflicted occupations listed in the increasing order of the mean age at notification of the occupational contact dermatitis

Occupation	Median age (years) at notification of OCD	Female, n (%)	Male, n (%)
Bakers	24	119 (61.2)	126 (38.8)
Vocational schools	24.5	99 (70.7)	41 (29.3)
Hairdressers and beauticians	25	723 (98.5)	11 (1.5)
Restaurant workers	25	615 (64.4)	340 (35.6)
Hotel workers	25	62.6 (102)	37.4 (61)
Retail sale of cars, vans, and minibuses	25	12 (6.7)	167 (93.3)
Breeding of pigs and dairy cattle	25	63 (50.4)	62 (49.6)
Auto mechanics	26	5 (3.8)	126 (96.2)
Supermarket employees	29	139 (75.5)	45 (24.5)
Plumbers	32	1 (1.0)	96 (99.0)
Painters	33.5	67 (42.9)	89 (57.1)
Dentists and dental assistants	34	325 (95.9)	14 (4.1)
Builders	34.5	2 (2.4)	80 (97.6)
Butchers and slaughterhouse workers	35	92 (39.7)	140 (60.3)
Hospital workers	38	1607 (91.8)	143 (8.2)
Cleaning personnel	38	365 (77.8)	104 (22.2)
Residential institutions for people with disabilities	38	256 (92.8)	20 (7.2)
Child/nursery care workers	38	413 (93.7)	28 (6.3)
Mechanics other than auto mechanics	38	15 (10.9)	122 (89.1)
Nursing home workers	39	1222 (96.8)	40 (3.2)
Machining metalworkers	40	9 (8.8)	93 (91.2)
Manufacturing of windmills	40.5	45 (18.0)	205 (82.0)
Food production	41	131 (48.3)	140 (51.7)
Home care workers	41	263 (93.3)	19 (6.7)
Metalworkers other than machining	42	156 (19.0)	663 (81.0)
Production of pharmaceuticals	43	74 (72.5)	28 (27.5)
Production of plastic	44	45 (35.4)	82 (64.6)
Postal workers	48	44 (41.9)	61 (58.1)

Abbreviation: OCD, occupational contact dermatitis.

to preventing OCD. An overall IR of 42.5 per 10 000 workers per year signifies that further targeted preventive efforts are necessary.

4.4 | Occupational contact dermatitis and manufacturing of windmills

It is well known that working in the windmill industry poses a severe risk for developing contact dermatitis. A Danish study examining the exposures related to recognized OCD in Denmark in 2010 found that half of patients with allergic OCD caused by epoxy resins were employed in the windmill industry.¹⁷ In Denmark it is a legal requirement before working with epoxy to participate in an educational program about the hazards and required safety measures when working with epoxy.¹⁸ Nevertheless, a scandal erupted in Denmark in 2015-2016 when it was brought to light that in several windmill

companies workers were handling epoxy resins without the relevant safety measures, resulting in a small epidemic of contact allergies to epoxy.¹⁹ In our study we found a substantial and significant decrease in IR of OCD between 2007-2012 and 2013-2018 from 22.4 to 13.2 per 10 000 workers per year, respectively, suggesting an improvement within the windmill industry, but with an overall IR of 17.5 per 10 000 workers per year, which ranks as the fourth highest overall IR. Thus, it is obvious that further improvement is still needed.

4.5 | The rise of occupational contact dermatitis among child/nursery care workers and painters: Consequences of the methylisothiazolinone epidemic?

The biggest increase in IR of OCD between 2007-2012 and 2013-2018 was found among childcare workers, where the IR of

OCD rose statistically significant from 3.6 to 5.8 per 10 000 workers per year, corresponding to an increase of approximately 60%, and painters, where the IR of OCD rose from 9.8 to 11.8 per 10 000 workers per year (not statistically significant), corresponding to an increase of approximately 20%. There can be many reasons for this increase in OCD, one of which could be the increasing use of methylisothiazolinone (MI) as a preservative. MI has been used in industrial products such as paint since 2000, and in 2005 it was approved as a standalone preservative in cosmetics and household products in the European Union, resulting in a subsequent epidemic of allergic contact dermatitis to MI. While the exposure of painters to MI through paint is a well-known fact,²⁰ the exposure of childcare workers is more obscure in its nature. Childcare workers are known to have a substantial exposure to wet work, including the use of soaps, cleaning agents, and wet wipes, all of which may contain MI as a preservative. A study from Australia found baby wipes to be an important source of exposure to MI among parents with hand dermatitis.²¹ In comparison, hospital workers also have a substantial exposure to wet work, but are exposed to a more standardized selection of soaps, cleaning agents, and wet wipes bought collectively from the same supplier, whereas childcare workers are exposed to a more varying selection, as each childcare facility is responsible for buying its own supplies, making it vulnerable to products of more varying quality.

In 2017 the use of MI was substantially restricted in the European Union, but as we compare the two periods 2007–2012 and 2013–2018, the consequences of the restriction in the use of MI are not likely to manifest itself in our results. A Danish study from 2020 found a steep incline in the prevalence of MI patch test positivity from 2010 to 2013, and a decline from 2017 to 2019.²²

4.6 | Strength and weakness

The strength of this study was the use of comprehensive register data of an entire country comprising a very large study population. When combining data on all recognized cases of OCD with reliable data from Statistics Denmark on the number of full- and part-time employed workers in the various examined occupations, it was possible to perform a population-based study on the IRs of OCD in Denmark. A weakness was the proxy use of DB07 classification in the DLMI register and Statistics Denmark. The problem with the DB07 classification in the context of this study is that it is primarily based on the industry of the persons place of employment, and not on the specific work tasks of the person. For this reason, we cannot be certain that a person registered with the DB07 code corresponding to “Cleaning personnel” is working with cleaning or working with administration within the cleaning company. This problem is especially apparent for the occupations “Vocational schools” and “Retail sale of cars, vans and minibuses,” that most likely comprise students of craftsmanship and auto mechanics working in affiliated auto repair shops, respectively. However, as administrative posts are rare and usually not related to OCD, this will mean that the incidence will be on the conservative side.

When calculating the IR based on the number of employees in Denmark in the same field and period, it is necessary to choose to either include both part- and full-time employees or only full-time employees. We chose to include both part- and full-time employees, as it is possible to get an OCD recognized from working a part-time job. Furthermore, having a part-time job is frequent among several of the high-risk occupations for developing OCD, that is, hairdressing and the cleaning industry. A problem with this approach is that the calculated IRs are only comparable to other studies that also include part-time employees.

4.7 | Conclusion

The data presented in this study are important for the planning of future preventive efforts. We found low median age at notification in several of the examined occupations, supporting previous findings that OCD affects young people in the beginning of their career.^{11,12} Considering the grave consequences OCD can have on future work life and quality of life,^{2–4} these findings stress the need for further preventive strategies among younger employees. The highest IR was found among hairdressers and beauticians, which are well-known at-risk occupations for the development of OCD, and even though we found a significant reduction in the IR rate of OCD among hairdressers and beauticians of approximately 35%, the IRs of OCD among hairdressers and beauticians remain the highest among the 28 most afflicted occupations, signifying the need for further prevention. Furthermore, we found bakers, dentists and dental assistants, and manufacturing of windmills among others to be high-risk occupations for the development of OCD, and as such future preventive efforts should also be directed towards these occupations. We detected a statistically significant increase in IR of OCD among childcare workers of approximately 60%, which could be the result of the use of MI in everyday products, but further research in this area is needed, as well as the development of preventive strategies in this field.

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AUTHOR CONTRIBUTIONS

Torkil Menné: Conceptualization; methodology; writing-review & editing. **Harald Meyer:** Writing-review & editing. **Sven Viskum:** Writing-review & editing. **Mari-Ann Flyvholm:** Conceptualization; funding acquisition; writing-review & editing. **Ulrik Ahrensboell-Friis:** Writing-review & editing. **Swen Malte John:** Writing-review & editing.

CONFLICTS OF INTERESTS

The authors declare no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the Danish Labour Market Insurance Register and Statistics Denmark

(DREAM). Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the Danish Labour Market Insurance and Statistics Denmark with the permission of the Danish Data Protection Board.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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