

Increased occurrence of hand eczema in young children following the Danish hand hygiene recommendations during the COVID-19 pandemic

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Abstract

Background: During the first wave of the COVID-19 pandemic of Spring 2020, Denmark was one of the first countries to introduce lockdown measures, including closing of all daycare centers. Following the reopening of daycare centers, Danish Health Authorities implemented a mandatory intensive hand hygiene regimen.

Objectives: To examine the occurrence and point prevalence of hand eczema as a consequence of more intensive hand hygiene among Danish children attending daycare.

Methods: The heads of 1667 daycare centers in Denmark were contacted and asked to forward a link to a questionnaire to parents of the children attending the daycare center.

Results: Among 6858 children, 12.1% had hand eczema before reopening of daycare centers, whereas 38.3% reported hand eczema after the children returned to daycare. Of the children who never had hand eczema, 28.6% developed hand eczema after returning to daycare. The risk of hand eczema was significantly associated with atopic dermatitis, female gender, higher age, and frequency of handwashing.

Conclusion: Following the implemented hygiene regimen, a high proportion of young children rapidly developed hand eczema. Well-established prophylactic skin care might have spared a proportion of the children from developing hand eczema.

KEYWORDS

atopic dermatitis, children, contact dermatitis, hand eczema

1 | INTRODUCTION

Hand eczema acquired in childhood may have serious consequences. Not only does the skin disease cause subjective symptoms, including itching and pain, it may also cause sleep disturbances and avoidance of participation in social activities such as sport, play, or other activities actively involving the hands.^{1,2}

Repeated skin contact with chemical or physical agents such as water, soaps, and detergents disrupts the skin barrier, eventually leading to irritant contact dermatitis.³ Once hand eczema has developed,

even a minimal skin irritation like every-day exposure to water and soaps will maintain the skin damage, leading to chronic hand eczema.⁴ During the coronavirus disease 2019 (COVID-19) pandemic of spring 2020, Denmark was one of the first countries to introduce lockdown measures. This included closing of all daycare centers throughout Denmark by March 16, 2020. Daycare centers were reopened on April 15, 2020. To prevent the transmission of coronavirus, specific hand hygiene guidelines for children were issued by the Danish Health Authorities: Children were instructed to wash their hands for 45 to 60 seconds with water and soap at least every 2 hours and

specifically upon arrival at daycare, before and after meals, after toilet visits, after coughing/sneezing in the hand, and whenever hands were visibly dirty.⁵ Soon after the reopening of daycare centers, we witnessed a disturbing increase in young children presenting with hand eczema suspected to be caused by altered hand hygiene routines (Figure 1). We thus examined the incidence and point prevalence of hand eczema along with risk factors for the development of hand eczema among Danish children attending daycare during the COVID-19 pandemic.

2 | METHODS

2.1 | Questionnaire

The study was designed as a 100% anonymous parental self-administered survey. An electronic questionnaire was designed to explore the occurrence of dry skin and hand eczema following the implemented hand hygiene measures and further providing information regarding the treatment given. Questions included, "How many times per day did your child wash hands with soap at home before the COVID-19 pandemic?" and "How many times per day does your child wash hands with soap at home now during the COVID-19 pandemic?"

Answer options were given as intervals of three: "0 times/day", "1–3 times/day", "4–6 times/day", "7–9 times/day", "10–12 times/day", "13 to 15 times/day", and ">15 times/day". Further questions regarding the child's skin included: "In general, does your child have dry skin?", "Did a doctor ever tell you that your child has atopic dermatitis?", "Did your child develop dry skin (or worsening of dry skin) on the hands after returning to daycare?" with answer options "yes" and "no", "Did your child have hand eczema before returning to daycare?" with answer options "yes, before the daycare centers closed", "yes, developed while daycare centers were closed", and "no, my child did not have hand eczema before returning to daycare". We further asked, "Did your child develop hand eczema (or worsening of existing hand eczema) after returning to daycare?", with the answer options "yes, new eczema", "yes, worsening of existing hand eczema", and "no, my child did not develop hand eczema". The questions regarding previous or current hand eczema were introduced by the following description of eczema: "Eczema is an itchy skin disorder showing redness, dryness, and possibly blisters and oozing". Questions regarding skin symptoms included, "What symptoms did your child have from the current hand eczema?", with answer options "redness", "itching", "burning", "pain", "sleep disturbance", and "none of the above". Parents were then asked to grade the symptoms as "mild", "moderate", or "severe". Questions regarding time to onset of dry skin on the hands or hand eczema included, "How long



FIGURE 1 (A) Deterioration of hand eczema 3 days after returning to daycare in a 6-year-old girl with atopic dermatitis. (B) A 4-year-old boy developed moderate hand eczema 3–4 days after returning to daycare. (C) A 5-year-old girl developed mild hand eczema 3 days after returning to daycare

after returning to daycare did your child develop dry skin on the hands?", and "How long after returning to daycare did your child develop hand eczema?" with answer options given as intervals of three: "0 days", "1–3 days", "4–6 days", "7–9 days", "10–12 days", "13–15 days", and ">15 days". Questions concerning treatment included, "Did your child see a doctor because of the hand eczema?", "Did your child receive prescription medication for the hand eczema?", with answer options, "Topical corticosteroids", "Protopic/Elidel (Tacrolimus/Pimecrolimus)", "Antihistamine", "Other", and "How did you treat your child's hand eczema?", with answer options, "Emollient cream", "Topical corticosteroids", "Protopic/Elidel (Tacrolimus/Pimecrolimus)", "Oral antihistamine", "Refrained from washing hands", "Refrained from using hand sanitizer", "Kept the child at home", and "Other". The questionnaire was sent out on May 4, 2020 and closed for responses May 17, 2020.

2.2 | Participants

We contacted the administration of all 98 municipalities of Denmark to obtain e-mail addresses of the daycare centers throughout Denmark. Fifty-four replied, enabling us to contact 1667 daycare centers throughout Denmark by e-mail. It was voluntary for the head of the daycare center to forward the link with the questionnaire to the parents, and we did not send out any reminders or obtain information about execution. The head of the daycare center was encouraged to upload an invitation to participate and a link to the questionnaire using the institution's digital platform. If the parents had multiple children attending daycare, they were asked to complete the survey for each child.

2.3 | Statistics and data management

The questionnaire was constructed using Research Electronic Data Capture (REDCap), which was also used to store data. A chi-square test was used for binary data and results were expressed as odds ratios (ORs). To adjust for possible confounding factors, a binary logistic regression analysis was performed with "incident hand eczema" as the dependent variable, and gender, atopic dermatitis, age group (0–3 years, 4–7 years), and total daily number of hand washes after the reopening of daycare as explanatory variables. Statistical significance was predefined as a *P*-value of <.05. The data analysis was done using statistical software (STATA statistical software, College Station, Texas: StataCorp LP. Release 12).

3 | RESULTS

Parents of 7003 children returned the questionnaire. To facilitate the statistical analyses, 145 responses with missing answers regarding sex or age were deleted from the final data set, giving a sample of 6858 children. The children were 0–7 years old (mean 3.4 years, SD 1.37) and 49.7% (3410/6858) were girls.

Parents of 42.7% (2925/6847) of the children responded affirmative to the question: "In general, does your child have dry skin". A current or previous diagnosis of atopic dermatitis was confirmed by the parents of 19.9% (1362/6845, 95% confidence interval [CI]: 19.0–20.9%) of the children, 2.2% (151/6842, 95% CI: 1.9–2.6%) suffered from hay fever, and 9.9% (679/6835, 95% CI: 9.2–10.7%) of the parents reported that their child suffered from symptoms of asthma. Table 1 shows the occurrence of dry skin and hand eczema stratified by atopic dermatitis and gender.

Parents of 63.5% (4303/6777, 95% CI: 62.3–64.6%) of the children reported that their child developed dry skin on the hands after returning to daycare and this was significantly associated to atopic dermatitis (adjusted OR 1.47, 95% CI: 1.29–1.68, *P* < .001) and female gender (adjusted OR 1.32, 95% CI: 1.19–1.47, *P* < .001).

Overall, 7.0% (475/6792, 95% CI: 6.4–7.6%) of the parents answered that their child had hand eczema before the society lock down and daycare were centers closed. Another 5.1% (345/6792, 95% CI: 4.6–5.6%) developed hand eczema while daycare centers were closed. Thus 12.1% (820/6792, 95% CI: 11.3–12.9%) of the children had hand eczema before reopening of daycare centers on April 15, 2020. This prevalence increased to 38.3% (2600/6795, 95% CI: 37.1–39.4%) after the children returned to daycare and the strict hand hygiene regimen was implemented, which was a statistically significant increase by 26.2 percentage points (*P* < .001).

The large share of children with previous hand eczema was explained by atopic dermatitis, as 22.9% (308/1345, 95% CI: 20.7–25.2%) of children with current or previous atopic dermatitis had hand eczema before daycare centers were closed. While day care centers were closed, another 6.9% (93/1345, 95% CI: 5.6–8.4%) developed hand eczema, giving a total of 29.8% (401/1345, 95% CI: 27.3–32.3%) children with atopic dermatitis who had hand eczema before returning to daycare. After returning to daycare, the prevalence of hand eczema among children with atopic dermatitis increased to 61.3% (826/1348, 95% CI: 58.6–63.9%). This was a significant increase by 31.5 percentage points (*P* < .001).

Overall, 87.9% (5972/6792, 95% CI: 87.1–88.7%) parents answered that their child did not have hand eczema before the reopening of daycare centers. Among these, 28.6% (1668/5842, 95% CI: 27.4–29.7%) developed hand eczema after returning to daycare. In 51.0% (847/1661, 95% CI: 48.6–53.4%) hand eczema occurred within 3 days.

The risk of developing hand eczema without having a history of hand eczema was significantly associated with atopic dermatitis (adjusted OR 2.22, 95% CI: 1.91–2.59), female gender (adjusted OR 1.42, 95% CI: 1.26–1.60), and older age (adjusted OR 1.79, 95% CI: 1.59–2.03), and the frequency of handwashing (Table 2, Figure 2). A linear regression with number of handwashes as an explanatory variable gave an estimated coefficient of 0.036 with a corresponding standard error of 0.005. The effect of increased frequency of hand washing was similar among children with atopic dermatitis as compared to children without atopic dermatitis.

We identified four subgroups: (1) Children without any history of atopic dermatitis or previous hand eczema ("previously healthy"),

TABLE 1 Responses to questions regarding dry skin and hand eczema stratified by atopic dermatitis and gender

	Total % (n/n _{total})	History of atopic dermatitis % (n/n _{total})	No history of atopic dermatitis % (n/n _{total})	OR (95% CI) P-value	Girls % (n/n _{total})	Boys % (n/n _{total})	OR (95% CI) P-value
In general, does your child have dry skin?	42.7 (2925/6847) 57.3 (3922/6847)	86.6 (1177/1359) 13.4 (182/1359)	31.8 (1745/5480) 68.2 (3735/5480)	13.8 (11.72–16.34) <.001	44.5 (1517/3406) 55.5 (1889/3406)	40.9 (1408/3441) 59.1 (2033/3441)	1.16 (1.05–1.28) <.05
Did your child develop dry skin on the hands after returning to daycare? ^a	63.5 (4303/6777) 36.5 (2474/6777)	68.5 (912/1331) 31.5 (419/1331)	62.2 (3381/5436) 37.8 (2055/5436)	1.32 (1–16–1.50) <.001	66.7 (2246/3366) 33.3 (1120/3366)	60.3 (2057/3411) 39.7 (1351/3411)	1.31 (1.20–1.46) <.001
Did your child have hand eczema before the daycare centers were closed on March 16, 2020?	7.0 (475/6792) 93.0 (6317/6792)	22.9 (308/1345) 77.1 (1037/1345)	3.1 (166/5437) 96.9 (5271/5437)	9.43 (7.72–11.53) <.001	7.8 (262/3377) 92.2 (3115/3377)	6.2 (213/3415) 93.8 (3202/3415)	1.26 (1.05–1.53) <.05
Did your child have hand eczema before returning to daycare on April 15, 2020?	12.1 (820/6792) 87.9 (5972/6792)	29.8 (401/1345) 70.2 (944/1345)	7.7 (417/5437) 92.3 (5020/5437)	5.11 (4.39–5.96) <.001	13.4 (452/3377) 86.6 (2926/3377)	10.8 (369/3415) 89.2 (3046/3415)	1.27 (1.10–1.47) <.005
Did your child develop hand eczema after returning to daycare? ^b	28.6 (1668/5842) 71.4 (4174/5842)	41.3 (363/879) 58.7 (516/879)	26.3 (1303/4955) 73.7 (3652/4955)	1.97 (1.70–2.29) <.001	31.9 (911/2855) 68.1 (1944/2855)	25.3757/2987) 74.7 (2230/2987)	1.38 (1.23–1.55) <.001
Was your child seen by a doctor because of the hand eczema that occurred after returning to daycare on April 15, 2020?	4.8 (115/2399) 95.2 (2284/2399)	6.8 (50/741) 93.2 (691/741)	3.9 (64/1654) 96.1 (1590/1654)	1.80 (1.23–2.63) <.05	5.1 (66/1306) 94.9 (1240/1306)	4.5 (49/1093) 95.5 (1044/1093)	1.13 (0.78–1.66) .52

^aDry skin on hands defined as incident cases of dry skin on hands, that is, children without previous parental self-reported dry skin on hands.^bHand eczema defined as incident cases of hand eczema, that is, children without previous parental self-reported hand eczema.

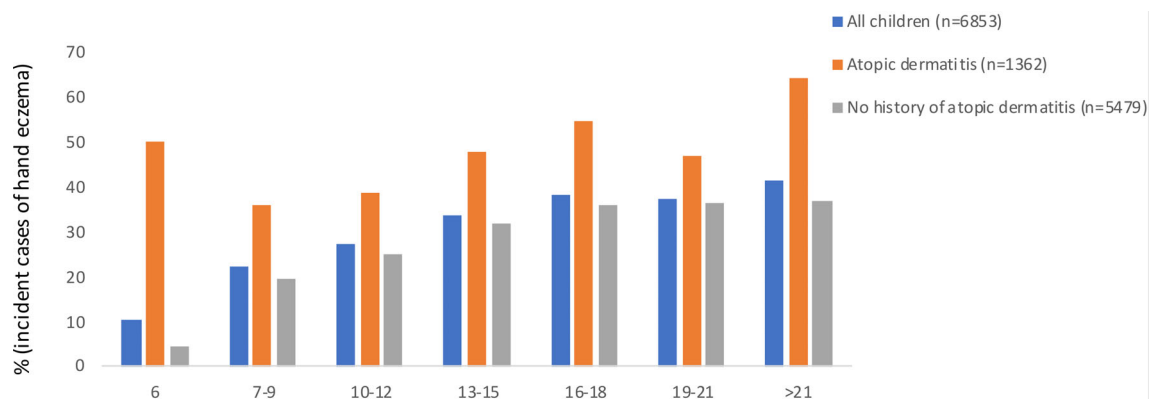
TABLE 2 The risk of incident hand eczema

Explanatory variables	Proportion with and eczema ^a	OR _{crude} (95% CI)	OR _{adjusted} ^b (95% CI)	P-value
Gender	31.9 (911/2855)	1.38 (1.23–1.55)	1.42 (1.26–1.60)	<.001
Girl	25.3 (757/2987)	1 (ref)	1 (ref)	
Boy				
Atopic dermatitis	41.3 (363/879)	1.97 (1.70–2.29)	2.22 (1.91–2.59)	<.001
Yes	26.3 (1303/4955)	1 (ref)	1 (ref)	
No				
Age	22.2 (654/2947)	1 (ref)	1 (ref)	<.001
0–3 years	35.0 (1014/2895)	1.89 (1.68–2.12)	1.79 (1.59–2.03)	
4–7 years				
Number of handwashes per day after returning to daycare on April 15, 2020	10.2 (5/49)	1(ref)	1 (ref)	c
6	22.4 (329/1468)	2.54 (1.00–6.46)	2.05 (0.80–5.25)	
7–9	27.2 (657/2419)	3.28 (1.30–8.31)	2.36 (0.92–6.02)	
10–12	33.9 (404/1192)	4.51 (1.78–11.47)	3.09 (1.20–7.91)	
13–15	38.3 (189/494)	5.45 (2.12–14.00)	3.67 (1.42–9.52)	
16–18	37.6 (53/141)	5.30 (1.98–14.20)	3.54 (1.31–9.56)	
19–21	41.3 (31/75)	6.20 (2.21–17.42)	4.00 (1.43–11.67)	
>21				

^aHand eczema defined as incident cases of hand eczema, that is, children without previous hand eczema.

^bAdjusted for gender, atopic dermatitis, age, and frequency of handwashing after returning to daycare.

^cTrend P-value <.001.

**FIGURE 2** The relationship between incident hand eczema and frequency of handwashing

(2) children with current or previous atopic dermatitis but without previous hand eczema, (3) children with previous hand eczema but no history of atopic dermatitis, and (4) children with both current or previous atopic dermatitis and previous hand eczema.

Children with previous hand eczema regardless of atopic dermatitis washed their hands more frequently both before and during the COVID-19 pandemic (Figures 3a and b). Deterioration of existing hand eczema or development of incident hand eczema happened earlier among children with previous hand eczema or atopic dermatitis as compared to children without preexisting skin disease (Figure 4).

Of the 2600 children who developed hand eczema or deterioration of hand eczema after returning to daycare, 23.2% (603/2600, 95% CI: 21.5–24.8%) had moderate or severe itching, 26.2% (680/2600, 95% CI: 24.5–27.9%) had moderate or severe burning, and

12.6% (328/2600, 95% CI: 11.4–14.0%) had moderate or severe pain. Finally, the hand eczema caused sleep disturbance in 6.5% (168/2600, 95% CI: 5.5–7.5%) of the children.

Of the 2399 parents who answered the question regarding medical care, 4.8% (115/2399, 95% CI: 3.97–5.72%) answered that their child was seen by a doctor. Of all children with hand eczema, 89.4% (2324/2600, 95% CI: 88.1–90.5%) were treated with emollient cream, 26.9% (700/2600, 95% CI: 25.2–28.7%) refrained from the use of hand sanitizer, 15.9% (413/2600, 95% CI: 14.5–17.3%) were treated with topical corticosteroids, 8.7% (227/2600, 95% CI: 7.7–9.9%) avoided handwashing, 5.5% (143/2600, 95% CI: 4.7–6.4%) chose to keep their child home from daycare, 1.6% (41/2600, 95% CI: 1.1–2.1%) were treated with oral antihistamine, and 1.3% (35/2600, 95% CI: 0.9–1.9%) were treated with topical tacrolimus/pimecrolimus (Table 3).

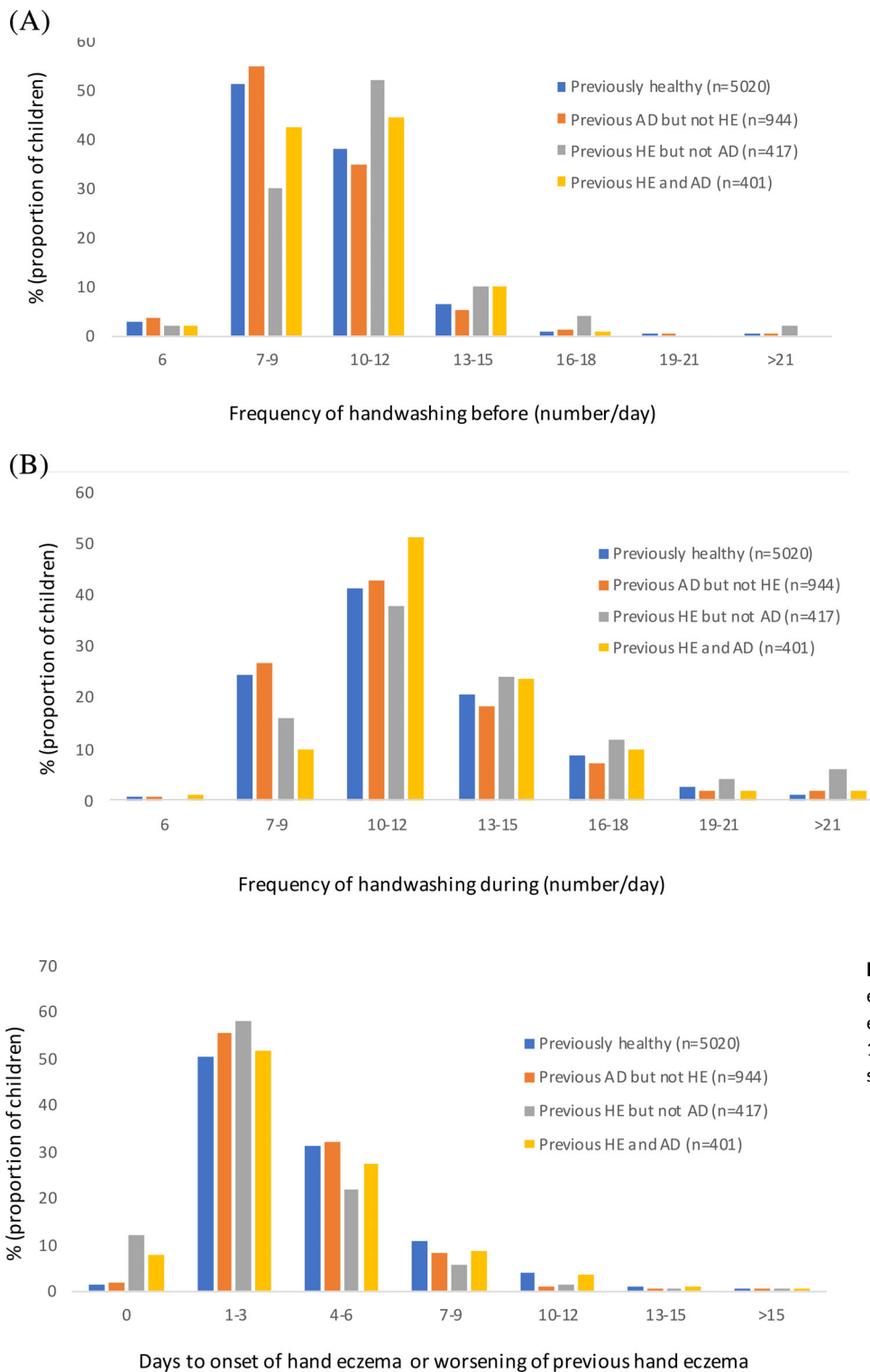


FIGURE 3 (A) The proportion of children in each of the four subgroups by frequency of handwashing before the lockdown March 16, 2020. (B) The proportion of children in each of the four subgroups by frequency of handwashing during the COVID-19 pandemic

FIGURE 4 Days to onset of hand eczema or worsening of previous hand eczema after returning to daycare April 15, 2020 for children in each of the four subgroups

4 | DISCUSSION

Knowing the etiology of irritant contact dermatitis, a sudden and dramatic epidemic of hand eczema in children was predictable. Following the Danish lockdown measures, citizens were instructed to dramatically increase hand hygiene measures including frequent handwashing. Before the lockdown, which included closing of daycare

centers, 7.0% of the children had hand eczema. This increased to 12.1% during the lockdown, when handwashing was more frequent than before, and further to 38.3% after the children returned to daycare and the strict hand hygiene regimen was implemented. The risk of incident hand eczema was strongly associated with atopic dermatitis and moderately with female gender, and the risk increased significantly with increasing frequency of handwashing. Of the children

TABLE 3 Treatment/actions taken because of hand eczema

Treatment/actions taken because of hand eczema	% (n/n _{total} ^a)
Application of emollient	89.4 (2324/2600)
Application of topical corticosteroid	15.9 (413/2600)
Use of oral antihistamine	1.6 (41/2600)
Application of topical tacrolimus/pimecrolimus	1.3 (35/2600)
Avoidance of hand sanitizer	26.9 (700/2600)
Avoidance of handwashing	8.7 (227/2600)
Kept the child at home	5.5 (143/2600)

^aTotal = all children with hand eczema.

with no history of previous hand eczema, 28.6% developed hand eczema, and in the majority of cases this occurred within few days after returning to daycare.

Hand eczema is a common skin disease in adults.⁶ For instance, a life time prevalence of 22% and a 1-year prevalence of 12% among Danish adults from the general population has been reported. Hand eczema in young children is usually attributed to atopic dermatitis⁷ or allergic contact dermatitis.^{8–10} Based on their 2013 public health survey, the Swedish Institute of Environmental Medicine found self-reported hand eczema in 6.1% and 6.8% of 4- and 12-year-old children, respectively.¹¹ In the present study, 7.0% had hand eczema even before daycare centers were closed, which to a large extent was explained by atopic dermatitis, but irritant contact dermatitis may also constitute a significant share, as children with previous hand eczema washed their hands more often than children without pre-existing skin disease. The intensive hand hygiene regimen was implemented in daycare centers as well as in primary schools throughout Denmark. In a similar study among Danish school children, 40.9% without previous hand eczema developed hand eczema after returning to school.¹² An explanation for this could be that school children have higher compliance with hand hygiene recommendations.¹³

The prevalence of atopic dermatitis in our study was 19.9%, which is in agreement with the existing data on atopic dermatitis epidemiology.¹⁴ The skin barrier in atopic dermatitis patients is inherently impaired, and previous or current atopic dermatitis is a strong risk factor for the development of irritant dermatitis and hand eczema,¹⁵ as our study confirms. Preventive measures are particularly important in this subgroup of children, as a history of atopic dermatitis and young age at onset are both important risk factors for a poor long-term prognosis.¹⁶

The prevalence of hand eczema is higher in adult women than men.¹⁷ Accordingly, we found a significantly higher risk of developing hand eczema among girls. This gender difference has traditionally been explained by different environmental exposures, and not by a genuine difference in skin susceptibility between genders. Mortz et al¹⁸ found a significantly higher life time and 1-year prevalence of hand eczema among females in 12- to 16-year-old adolescents. However, in a Norwegian study the prevalence of hand eczema among

8- to 12-year-old boys and girls was identical.⁷ The role of the gender as a predisposing factor for irritant contact dermatitis is still debated. Although some authors have reported an increased irritant susceptibility in women compared with men,^{19,20} most experimental studies have not confirmed this gender difference in acute or cumulative irritant reactivity.^{21,22} In our study of hand eczema in young children there may have been behavioral differences between boys and girls, that is, girls may wash their hands more thoroughly and more often, at least among the older children in the study population. In line with this, children in the age group 4–7 years were significantly more likely to develop hand eczema as compared to younger children aged 0–3 years. This could be because the older children manage the hand washing themselves and the exposures are likely different, that is, the older children have a different behavior pattern and other preferences in terms of play and use of toys, and are further exposed to more frequent handwashing because of toilet visits, coughing, eating, and so on.

The frequency of direct skin contact with any irritant agent including soap and water determines the degree of skin barrier disruption.²³ The correlation between the frequency of handwashing and risk of hand eczema has previously been established.^{24,25} In this study we found a significant dose–response relationship between the frequency of handwashing and incident hand eczema.

Developing hand eczema in childhood does not only have immediate implications, but may potentially have serious long-term consequences. Repeated skin exposure to even weak irritants will eventually lead to chronic irritant contact dermatitis, and despite removal of the irritant, the clinical reaction may persist for years.²⁶ Another potential problem of intensified exposure to soap and disinfectants is the risk of contact allergy to ingredients. The risk of sensitization to allergens is increased in already inflamed and eczematous skin.^{27,28} Possible sensitizing agents commonly found in hand soaps include fragrance, preservatives, and emulsifiers.^{29–31}

Danish Health Authorities implemented the regimen of intensive hand hygiene to limit the transmission of corona-virus, based on the assumption that young children may be asymptomatic carriers of the virus. Children were instructed to wash their hands several times each day, whereas the role of hand sanitizer was limited. Repeated handwashing disrupts the skin barrier, while using a hand sanitizer containing glycerol instead is much gentler.³² Due to inquiries from general practitioners and dermatologists who witnessed a rapidly increasing number of children with hand eczema, the instructions for hand hygiene were revised as of April 23, 2020. The revised guidelines recommended use of lipid-rich moisturizer after each hand wash or as frequent as possible. In addition, the new guidelines recommended using lukewarm water, to wet the hands before applying soap, to thoroughly rinse hands free of soap, and to gently dry the hands after washing.

The major strength of this study is the size of the study population, which geographically covers the entire country and thus represents all social classes. A limitation of the study is that we have no information regarding non-responders and the number of parents that received the invitation. Although the high prevalence of hand eczema

of 28.6% may raise concern for participation bias, the estimates of atopic dermatitis and hand eczema before the COVID-19 pandemic are similar to those from previous studies.^{11,14,33} Another limitation is that the end points were self-reported (by parents). Caregiver-reported history of ever having childhood eczema was previously shown to have a high sensitivity of 83% and specificity of 89%.³³ The question concerning the main outcome hand eczema was also previously validated and found to have a high specificity 96.3% and moderate sensitivity 70.3% compared to a doctor's examination and diagnosis,³⁴ so the results on incidence and prevalence of hand eczema in this study would be conservative. However, the sudden increase of hand eczema in young children made headlines in newspapers and television at the time. This could potentially have increased the detection rate. A final limitation of the study is that we have no information regarding the severity of hand eczema.

5 | CONCLUSION

Following the implemented hygiene regimen in Danish daycare centers, a significant share of children rapidly developed hand eczema. Prophylactic measures should have been implemented along with the hand hygiene regimen, including instructions on how to perform correct handwashing, with emphasis on the use of hand sanitizers (with glycerol) as a gentler hygiene measure, and the use of emollient cream following handwashing. Finally, it remains unknown to what degree the intensive hand hygiene regimen among Danish children attending daycare actually prevented coronavirus transmission.

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The parents of the children depicted in Figure 1 have given written informed consent to publication of the clinical photos.

AUTHOR CONTRIBUTIONS

Anne Birgitte Simonsen: Conceptualization; data curation; formal analysis; methodology; project administration; writing-original draft; writing-review and editing. **Iben Ruge:** Data curation; methodology; software; visualization; writing-review and editing. **Anna Quaade:** Investigation; project administration; visualization; writing-review and editing. **Jeanne Duus Johansen:** Conceptualization; formal analysis; methodology; supervision; writing-review and editing. **Jacob Thyssen:** Conceptualization; investigation; methodology; project administration; supervision; writing-review and editing. **Claus Zachariae:** Conceptualization; investigation; methodology; project administration; supervision; writing-review and editing.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

1. Moberg C, Alderling M, Meding B. Hand eczema and quality of life: a population-based study. *Br J Dermatol*. 2009;161(2):397-403.
2. Beattie PE, Lewis-Jones MS. A comparative study of impairment of quality of life in children with skin disease and children with other chronic childhood diseases. *Br J Dermatol*. 2006;155(1):145-151.
3. Rustemeyer T, van Hoogstraten IMW, von Blomberg BME, Gibbs S, Scheper RJ. Mechanisms of irritant and allergic contact dermatitis. In: Johansen JD, Frosch PJ, Lepoittevin J-P, eds. *Contact Dermatitis*. Vol 1. 5th ed. Berlin Heidelberg: Springer-Verlag; 2011:43-90.
4. Agner T, Elsner P. Hand eczema: epidemiology, prognosis and prevention. *J Eur Acad Dermatol Venereol*. 2020;34(Suppl 1):4-12.
5. Guidelines for Reopening of Daycare Centers and Schools, 2020. <https://www.skolelederforeningen.org/nyheder-medier/nyheder/2020/genaabning-saa-kom-sundhedsstyrelsens-vejledninger-ifm-aabning-af-skoler-mm/>. Accessed April 16, 2020.
6. Thyssen JP, Linneberg A, Menné T, Nielsen NH, Johansen JD. The effect of tobacco smoking and alcohol consumption on the prevalence of self-reported hand eczema: a cross-sectional population-based study. *Br J Dermatol*. 2010;162(3):619-626.
7. Dotterud LK, Falk ES. Contact allergy in relation to hand eczema and atopic diseases in north Norwegian school children. *Acta Paediatr*. 1995;84(4):402-406.
8. Isaksson M, Olhardt S, Radehed J, Svensson Å. Children with atopic dermatitis should always be patch-tested if they have hand or foot dermatitis. *Acta Derm Venereol*. 2015;95(5):583-586. <https://doi.org/10.2340/00015555-00011995>
9. Flohr C, Ravenscroft J, English J. Compositae allergy in three children with hand dermatitis. *Contact Dermatitis*. 2008;59(6):370-371.
10. Aerts O, De Fre C, van Hoof T, Ghys K, Ortopelea RA, Lambert J. "Slime": a new fashion among children causing severe hand dermatitis. *Contact Dermatitis*. 2018;79(6):385-387.
11. Lidén C, Julander A, Meding B. *Hudallergi*. The Swedish Institute of Environmental Medicine; 2013.
12. Simonsen AB, Ruge IF, Quaade AS, Johansen JD, Thyssen JP, Zachariae C. High incidence of hand eczema in Danish school children following intensive hand hygiene during the COVID-19 pandemic - a nationwide questionnaire study. *Br J Dermatol*. 2020 [Epub online ahead of print]. <https://dx.doi.org/10.1111/bjd.19413>
13. Chen X, Ran L, Liu Q, Hu Q, Du X, Tan X. Hand hygiene, mask-wearing behaviors and its associated factors during the COVID-19 epidemic: a cross-sectional study among primary school students in Wuhan, China. *Int J Environ Res Public Health*. 2020;17(8):2893. <https://dx.doi.org/10.3390/ijerph17082893>
14. Bieber T. Atopic dermatitis. *N Engl J Med*. 2008;358(14):1483-1494. <https://doi.org/10.1056/NEJMra074081>
15. Ruff CA, Belsito DV. The impact of various patient factors on contact allergy to nickel, cobalt, and chromate. *J Am Acad Dermatol*. 2006;55(1):32-39. Epub 2006 May 2016.
16. Meding B, Wrangsjö K, Järholm B. Fifteen-year follow-up of hand eczema: predictive factors. *J Invest Dermatol*. 2005;124(5):893-897.
17. Thyssen JP, Linneberg A, Menné T, Johansen JD. The epidemiology of contact allergy in the general population—prevalence and main findings. *Contact Dermatitis*. 2007;57(5):287-299.
18. Mortz CG, Lauritsen JM, Bindlev-Jensen C, Andersen KE. Prevalence of atopic dermatitis, asthma, allergic rhinitis, and hand and contact dermatitis in adolescents. The Odense adolescence cohort

- study on atopic diseases and dermatitis. *Br J Dermatol*. 2001;144(3): 523-532.
19. Goh CL, Chia SE. Skin irritability to sodium lauryl sulphate—as measured by skin water vapour loss-by sex and race. *Clin Exp Dermatol*. 1988;13(1):16-19.
 20. Cowley NC, Farr PM. A dose-response study of irritant reactions to sodium lauryl sulphate in patients with seborrhoeic dermatitis and atopic eczema. *Acta Derm Venereol*. 1992;72(6):432-435.
 21. Lammintausta K, Maibach HI, Wilson D. Irritant reactivity in males and females. *Contact Dermatitis*. 1987;17(5):276-280.
 22. Tupker RA, Coenraads PJ, Pinnagoda J, Nater JP. Baseline trans-epidermal water loss (TEWL) as a prediction of susceptibility to sodium lauryl sulphate. *Contact Dermatitis*. 1989;20(4):265-269.
 23. Bains SN, Nash P, Fonacier L. Irritant contact dermatitis. *Clin Rev Allergy Immunol*. 2019;56(1):99-109.
 24. Behroozy A, Keegel TG. Wet-work exposure: a main risk factor for occupational hand dermatitis. *Safe Health Work*. 2014;5(4):175-180.
 25. Carøe TK, Ebbelhøj NE, Bonde JPE, Flachs EM, Agner T. Hand eczema and wet work: dose-response relationship and effect of leaving the profession. *Contact Dermatitis*. 2018;78(5):341-347.
 26. Petersen AH, Johansen JD, Hald M. Hand eczema-prognosis and consequences: a 7-year follow-up study. *Br J Dermatol*. 2014;171(6): 1428-1433.
 27. Kohli N, Nedorost S. Inflamed skin predisposes to sensitization to less potent allergens. *J Am Acad Dermatol*. 2016;75(2):312-317. e1. <https://dx.doi.org/10.1016/j.jaad.2016.03.010>
 28. Gittler JK, Krueger JG, Guttman-Yassky E. Atopic dermatitis results in intrinsic barrier and immune abnormalities: implications for contact dermatitis. *J Allergy Clin Immunol*. 2012;131(2):300-313.
 29. Rastogi SC, Heydorn S, Johansen JD, Basketter DA. Fragrance chemicals in domestic and occupational products. *Contact Dermatitis*. 2001;45(4):221-225.
 30. Warshaw EM, Goodier MC, DeKoven JG, et al. Contact dermatitis associated with skin cleansers: retrospective analysis of north American contact dermatitis group data 2000-2014. *Dermatitis*. 2018;29(1):32-42.
 31. Zemtsov A, Taylor JS, Evey P, Dijkstra J. Allergic contact dermatitis from formaldehyde in a liquid soap. *Cleve Clin J Med*. 1990;57(3): 301-303.
 32. Pedersen LK, Held E, Johansen JD, Agner T. Less skin irritation from alcohol-based disinfectant than from detergent used for hand disinfection. *Br J Dermatol*. 2005;153(6):1142-1146.
 33. Silverberg JI, Patel N, Immaneni S, et al. Assessment of atopic dermatitis using self-report and caregiver report: a multicentre validation study. *Br J Dermatol*. 2015;173(6):1400-1404.
 34. Bregnhøj A, Søsted H, Menné T, Johansen JD. Validation of self-reporting of hand eczema among Danish hairdressing apprentices. *Contact Dermatitis*. 2011;65(3):146-150.

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