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# Preventive and curative approaches to diaper dermatitis in children: a systematic review

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**Abstract**

Diaper dermatitis (DD) is a common inflammatory skin condition in the diaper area of infants, caused by a combination of host and environmental factors, such as moisture, friction, elevated skin pH, and prolonged exposure to urine and feces. This systematic review analyzed 13 studies involving 2,935 children to evaluate effective treatment and prevention strategies for DD. Key interventions identified include the use of disposable and emollient-containing diapers, gentle skincare practices (such as bathing every 1 to 2 days with mild cleansers and emollients), and pH-balanced wet wipes. Frequent diaper changes and allowing diaper-free time also help reduce skin irritation. Topical treatments, particularly emollients with zinc oxide or dexpanthenol, were found to be highly effective with minimal side effects. Preventive measures, such as using superabsorbent disposable diapers, regular application of barrier creams, and maintaining good hygiene, are crucial in reducing the incidence and severity of DD. In conclusion, a combined approach of proper diaper selection, gentle skincare, and judicious use of topical emollients is recommended for both treatment and prevention of DD in children.

**Keywords:** children, diaper dermatitis, infants, prevention, therapy

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## Introduction

Diaper dermatitis (DD), also known as diaper rash, is an inflammatory condition in the genital area, buttocks, thighs, and groin, which are parts of the body that come in contact with diapers (1). It most frequently develops in neonates and infants, with a prevalence ranging from 7% to 50%. Another group of individuals with a fairly frequent incidence of DD is the elderly, with a prevalence of 5.6% to 50% (2, 3). Diapers that are too occlusive lead to increased skin moisture, which is further exacerbated by the presence of urine and feces, changes in skin pH, and *Candida albicans* fungal infections. *C. albicans* is associated with skin irritation, which in turn causes DD (4).

DD is a multifactorial disease influenced by both intrinsic (host) and extrinsic (environmental) factors. Environmental factors comprise prolonged skin contact with urine and feces, friction, moisture retention due to occlusive diapers, and altered skin pH (5, 6). Host factors include the individual susceptibility and immune responses. Children are more susceptible to various skin disorders than adults due to the incomplete development of their skin barriers (7–9). The skin in the diaper area can experience overhydration and an increase in pH due to contact with urine and feces, which then impacts the degradation of the skin barrier, especially in the stratum corneum layer (10, 11). This damage to the skin barrier will facilitate the colonization of pathogens on the skin, causing infection and skin inflammation. *C. albicans*, *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus* spp., and *Bacteroides* spp. have been identified as some of the microorganisms that cause DD (12, 13).

The clinical manifestations of DD include erythematous papules, erosions, and scales on the skin covered by diapers (4). When associated with a *C. albicans* infection, it also presents with edema and erythematous plaques accompanied by satellite lesions in the form of papules and pustules (12). The diagnosis of DD is typically based on the patient's history of diaper use. Supporting tests such as potassium hydroxide (KOH) preparation and polymerase chain reaction (PCR) can help confirm the diagnosis in cases with atypical clinical presentations (1, 14, 15).

DD management focuses on treatments to heal inflamed and infected skin, as well as preventing recurrence. Actions taken to achieve this include implementing proper hygiene, cleaning the skin in the diaper area with soap and water, and using wet wipes, topical emollients to maintain skin moisture, weak potency corticosteroids, antifungals, and antibiotics in cases with fungal and bacterial infections (12, 13).

It is important to emphasize that DD is primarily an irritant contact dermatitis, not an infectious disease. Continuous exposure of the skin to urine and feces leads to inflammation and disruption of the skin barrier. Infections with pathogens, such as *C. albicans* and *S. aureus*, are often found in the diaper area, and they typically represent secondary colonization or superinfection of already irritated skin. A proper understanding of this distinction is crucial to avoid unnecessary antimicrobial treatments and focus on barrier protection and preventive care. This systematic review addresses the therapy and prevention of DD, with a particular focus on its occurrence in children.

## Methods

### Study design

This systematic review was conducted based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. The articles reviewed were obtained from the PubMed and ScienceDirect databases. An article search was carried out using the following keywords: ((diaper dermatitis) OR (diaper rash)) AND ((management) OR (therapy) OR (treatment)) AND (prevention).

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### Eligibility criteria

The inclusion criteria for articles in this research were 1) cross-sectional, case control, cohort retrospective, cohort prospective, quasi-experimental, and randomized controlled trial (RCT) research; 2) English articles; 3) articles published over the past 10 years (i.e., from 2015 to 2024); 4) articles discussing therapy and/or prevention of DD; and 5) studies carried out on pediatric subjects. This systematic review excluded 1) articles in languages other than English; 2) articles not presented in full; 3) research focusing solely on adults; and 4) articles presenting case reports, reviews, systematic reviews, and meta-analyses.

### Study selection

After exporting the search results to the reference management software Mendeley (Elsevier, Amsterdam, NL) and removing duplicates, two reviewers independently screened the articles based on their titles and abstracts. The full text of potentially relevant articles was obtained and assessed against predefined criteria. A third reviewer was consulted to resolve any disagreements between the initial reviewers.

### Quality assessment

Study quality was assessed using Risk of Bias in Non-Randomized Studies – of Interventions (ROBINS-I) for non-randomized studies and Cochrane Risk of Bias (RoB) 2 for randomized trials. Two reviewers made critical assessments, with a third resolving disagreements. Traffic-light plots were utilized to display the risk of bias results, categorizing risks as low, high, or unclear.

### Data extraction and analysis

Data were extracted independently by three reviewers using predefined sheets. These included general study information (author, location, and publication year) and research characteristics (type and subjects), focus (therapy/prevention), and outcomes. The data extracted were then subjected to qualitative analysis.

## Results

### Study selection

During the initial search process, 665 articles were found. We excluded seven duplicate articles. The abstract review eliminated 164 articles, leaving 496 full-text articles for eligibility assessment. From a total of 496 articles, 13 studies were included in this systematic review, consisting of RCT ($n$ = 8), quasi-experimental ($n$ = 3), and cohort ($n$ = 2) studies (Fig. 1). The study included 2,935 child subjects 0 to 13 years old. There were two studies each from China and the United States, and one study each from Egypt, India, Turkey, Thailand, Italy, Iran, Switzerland, the UK, and Japan (Table 1).

The interventions explored in these studies included various preventative and curative approaches to DD. These ranged from comparing various types of diapers (disposable vs. cloth, diapers with new materials, and emollient-containing diapers) and skincare practices (bathing frequency, emollient use, and wet wipe composition) to comparing topical treatments (zinc oxide cream, talc, henna cream, hydrocortisone cream, hydrocolloid dressings, mupirocin plaster, and dexpanthenol ointment). We also highlight the reported efficacy of each intervention and any observed side effects (Table 1).

### Risk of bias assessment

RoB 2 assessment evaluated eight RCT studies across five domains (Fig. 2). Most studies demonstrated a low risk of bias, particularly in domains related to deviations from intended interventions (D2)

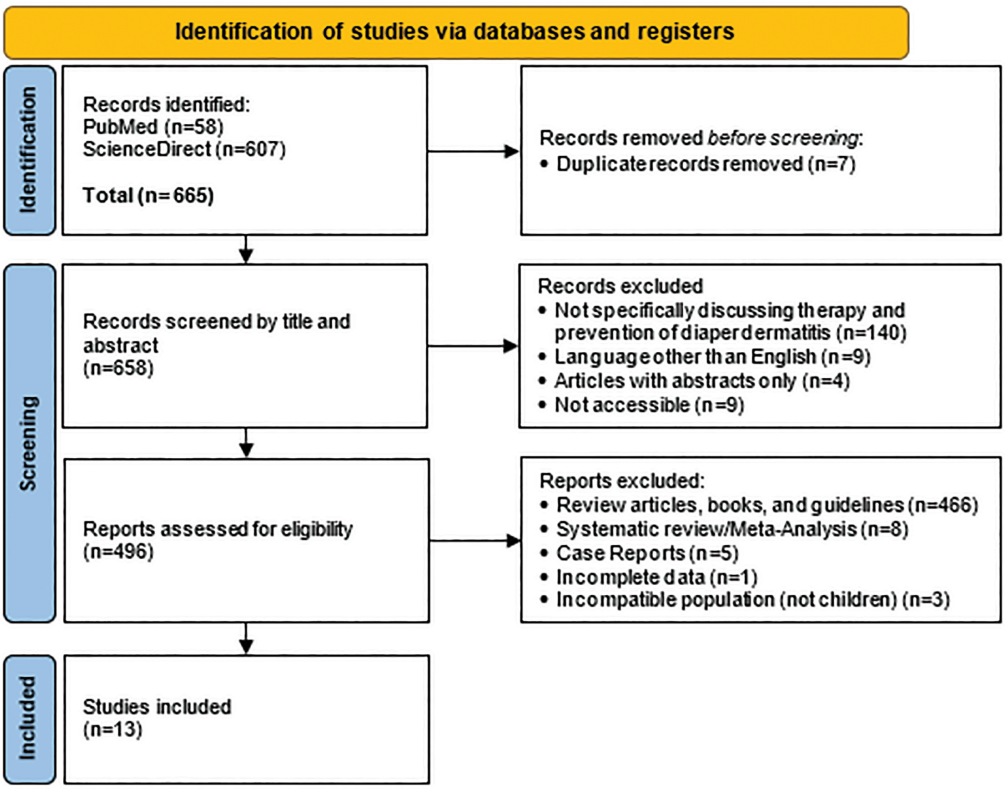


Figure 1 | Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flowchart.

and missing outcome data (D3), with all eight studies rated as low risk in D3. However, concerns arose in the randomization process (D1), the measurement of outcomes (D4), and the selection of reported results (D5). Overall, three studies were judged to have low risk, three had some concerns, and two had a high risk of bias.

Furthermore, the ROBINS-I assessment evaluated five studies across seven domains (Fig. 3). Most studies showed a low risk of bias in domains, such as selection of participants (D2), classification of interventions (D3), and missing data (D5). However, serious risks of bias were noted in the randomization process (D1) for two studies (2, 16) and in the measurement of outcomes (D6) for one study (2). Moderate risks were observed in deviations from intended interventions (D4) and the selection of reported results (D7) for some studies. Overall, three studies had moderate risk, and two were rated as having serious risk of bias.

## Discussion

This systematic review highlights the multifaceted approaches to both preventing and treating DD. The included studies explored a range of interventions, from comparing various diaper types and skincare practices to evaluating the efficacy of various topical treatments. The findings underscore the importance of gentle skincare practices, appropriate diaper selection, and judicious use of topical agents in managing and mitigating DD in infants and young children. Several studies demonstrated the benefit of disposable diapers over cloth diapers, and others focused on the advantages of diapers containing emollients or utilizing new materials designed to improve skin health. These insights contribute to a better understanding of modifiable factors that influence the development and severity of DD.

### Bathing

Bathing newborns is safe when basic precautions are followed, and it is generally more effective than cleaning with a cloth. Soap-free liquid cleansers formulated specifically for infant skin are recommended for bathing (28). These cleansers should have a neutral to acidic pH and contain only ingredients approved for infant use (29). Several studies highlighted bathing as an effective preventive measure for DD. For example, bathing once daily during the first 4 weeks of life was associated with a significantly lower incidence of DD (21). Another study showed that bathing every other day combined with daily emollient use resulted in better skin hydration and lower transepidermal water loss (TEWL), further reducing DD incidence (22).

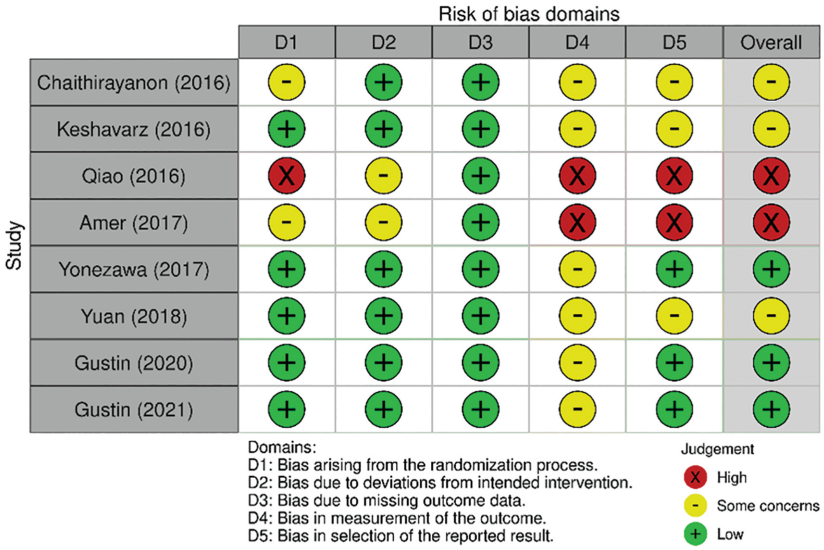


Figure 2 | Cochrane Risk of Bias (RoB2) traffic-light plot.

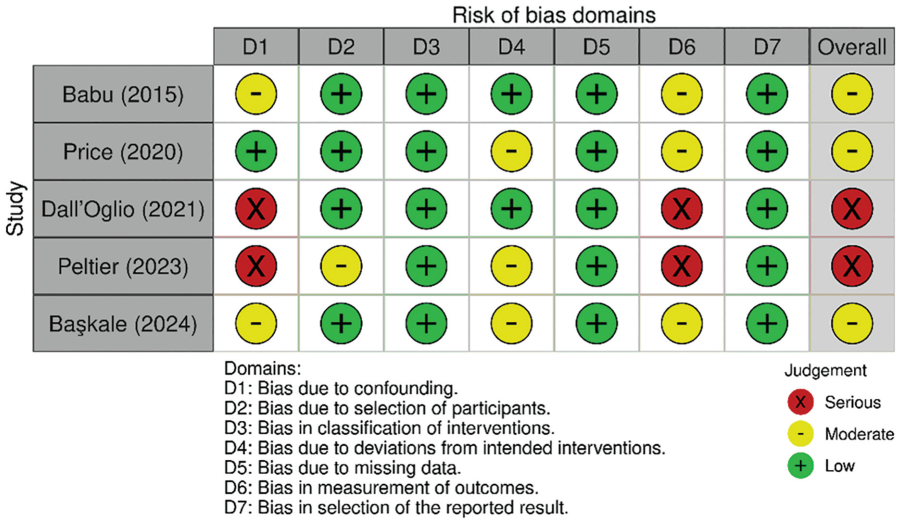


Figure 3 | Risk of Bias in Non-Randomized Studies – of Interventions (ROBINS-I) traffic-light plot.

### Wet wipes

Wet wipes were used in four studies. A study conducted in 2017 in Egypt identified the impact of both bathing and using wet wipes on the incidence of DD (21). With each diaper change, using wet wipes to clean the diaper area can reduce the incidence of DD by up to 45% (21). Another study, conducted in the United States on 38 children 7 months to 2 years old, also found that the use of wet wipes was beneficial. Wetting with a buffer can keep the pH of the skin in the diaper area neutral, thereby preventing damage to the skin barrier and decreasing the incidence of DD (24). In 2019, a study in England found that the use of wet wipes with minimal ingredients significantly reduced the incidence of DD (25). In addition, in subjects suffering from DD, the clinical manifestations tend to be milder than in subjects that use wet wipes containing lots of additives (25). Gustin et al. demonstrated that using wet wipes with an acidic pH helps maintain natural skin acidity in the diaper area, comparable to healthy skin, thereby reducing the risk of DD (26).

Baby wipes with different formulations are commercially available. The use of a pH buffer in baby wipes is critical to neutralize alkaline urine and maintain the acidity of the skin in the diaper area (5, 28). Products should not contain ingredients known to cause irritation, including alcohol, allergenic fragrances, essential oils, harsh soaps, non-optimal surfactants, or detergents such as sodium lauryl sulfate (30). Clinicians should be aware of DD in children due to substances used in wet wipes, such as the preservatives methylisothiazolinone (MI), methylchloroisothiazolinone (MCI), bronopol, and iodopropynyl. Wet wipes may create an environment conducive to microbial growth; therefore, they should contain safe and effective preservatives and be compatible with infant skin. Wet wipes containing irritating ingredients can damage the skin barrier, making it easier for irritants and pathogens to enter the skin (7, 31, 32).

### Topical therapy

Topical therapy emerged as the most frequently reported intervention for treating DD. Giving zinc oxide emollient to 70 neonates before using diapers reduced the incidence of DD by up to 45% (21). Another study reported that the use of emollient with topical hindmilk in the diaper area for 2 weeks can significantly reduce the incidence of DD (27). According to research conducted by Chaithirayanon, using zinc oxide emollient for 8 weeks was better at reducing the incidence of DD than using emollient with talc (18). Another study also reported that the use of a mild cleanser for 30 days could significantly improve erythematous lesions in the diaper area. There are no side effects reported with the use of mild cleansers (2).

Qiao et al. found that hydrocolloid dressings had the best cure rate and the lowest incidence of side effects in 210 children with DD (20). A study by Peltier et al. reported that the use of emollients with dexpanthenol led to 83% of subjects experiencing clinical improvement after 1 day of therapy, and 78% experiencing complete resolution 2 days after administering therapy (16). A study in Iran reported that applying henna cream for 5 days resulted in a cure rate of 90.2%. Meanwhile, administering hydrocortisone cream had a cure rate of 61% (19). In Japan, applying emollient after bathing to neonates 1 week to 3 months old reduced TEWL and increased skin hydration, thereby reducing the incidence of DD (22).

Studies have shown that skin care influences the skin barrier function. Emollients are commonly used in developed countries as both a preventive measure and first-line treatment for DD (5, 14). Emollient creams can protect the skin around the diaper area by covering the skin's surface and adding lipids that can move into the spaces between the cells of the stratum corneum. This keeps the skin from becoming wet or irritated and helps the stratum corneum heal. Appropriately formulated emollients can be used to support the skin barrier function as long as they are applied in a thin layer in the diaper area to avoid occlusion, and care must be taken to avoid the emollient becoming trapped in the folds, causing dysregulation of evaporation and microbial colonization (14). Emollients should be used at least twice a week on healthy baby skin. Various formulations are available for this purpose, containing zinc oxide, petrolatum, cod liver oil, dimethicone, lanolin, dexpanthenol, and Burow's solution. In addition, the inclusion of emollients in the top layer of diapers can help reduce the incidence of erythema and diaper rash (29).

### Diaper selection

The choice of diaper type can significantly impact the health of the skin in the diaper area. Babu et al. reported that the use of disposable diapers was more effective than cloth diapers in preventing DD. No side effects were reported related to the use of disposable diapers (21). A study in Italy reported that the use of "super-absorbent" diapers significantly reduced the degree of erythema in DD skin lesions in 10 children (2). Further, Gustin et al. found that the use of emollient diapers helped maintain skin pH and reduce the incidence of DD (24). Another study, conducted in China on 211 babies 3 to 24 months old, reported that the use of diapers with advanced materials maintained the skin condition in the diaper area as optimal as before the use of diapers (23). In addition, a 2021 study by Gustin et al. conducted in the United States on 90 babies with an average age of 5.5 weeks reported that the use of diapers with apertures and emollients in the inner lining reduced the incidence of DD and resulted in milder episodes of severe erythema in the diaper area compared to those using diapers without these features (26).

Diaper design and performance have improved greatly over the past few decades, leading to a decrease in the prevalence and severity of DD (10). Utilizing various diaper technologies that increase absorbency and reduce irritation and leakage can contribute to both the prevention and treatment of DD. Superabsorbent polymers, such as cross-linked sodium polyacrylate in the diaper core, form a gel in contact with urine, thereby reducing overhydration and skin friction, while helping normalize skin pH. This polymer has the capacity to absorb many times its weight in liquid (29). Modern superabsorbent disposable diapers have additional features, such as a top layer to absorb urine and liquid feces, and an acquisition layer just below the top layer to disperse the urine laterally and draw it into the superabsorbent core (33, 34). The outer layer, with good air circulation, consists of a microporous membrane that allows the flux of water vapor while preventing leakage, thereby reducing overhydration and skin occlusion. Materials with higher flexibility are used to improve comfort and reduce friction. The barrier emollient surface layer, which is transferred to the skin during normal diaper use, can prevent skin barrier breakdown when the skin is exposed to irritants (34, 35).

## Conclusions

DD treatment typically involves topical therapy, particularly emollients, which have a high cure rate and minimal side effects. The most recommended preventive measures include bathing every 1 to 2 days, using disposable diapers with high absorbency, an apertured topsheet containing emollients, applying emollients with zinc oxide, and using wet wipes with proven pH buffers and emollients to reduce the incidence of DD in children. In addition, pH-buffered wet wipes with minimal irritants are essential for maintaining skin integrity. Based on the evidence reviewed, we recommend a comprehensive skin-care regimen that includes routine hygiene, optimal diaper choice, and emollient use. These strategies should be emphasized in clinical guidelines and parent education, especially for children with developmental delays that may have prolonged diaper use and greater risk of DD.

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**Table 1** | **Studies related to diaper dermatitis (DD) therapy and prevention included in the review.**

| Author (year) | Country | Subjects | Study design | Therapy/prevention | Efficacy | Side effects |
|---|---|---|---|---|---|---|
| Babu et al. (2015) (17) | India | 253 neonates treated in the NICU for over 48 hours | Prospective cohort | Disposable vs. cloth diapers | Lower DD and sepsis rates with disposable diapers | Not reported |
| Chaithirayanon (2016) (18) | Thailand | 50 infants with an average age of 8 months | RCT | Talc vs. zinc oxide cream for 8 weeks | Zinc oxide cream is more effective than talc cream in reducing the incidence of DD. | Zinc oxide did not cause any side effects, whereas talc can cause respiratory side effects. |
| Keshavarz et al. (2016) (19) | Iran | 82 children with DD under 2 years | RCT | Henna cream vs. hydrocortisone cream three times a day for 5 days | Both groups showed a significant reduction in the severity of DD. Henna showed better healing (90.2% vs. 61%). | No significant side effects |
| Qiao et al. (2016) (20) | China | 210 pediatric patients with DD | RCT | Hydrocolloid dressing vs. mupirocin plaster vs. zinc oxide plaster | Hydrocolloid is most effective with fewer side effects. | Pustules, itching |
| Amer et al. (2017) (21) | Egypt | 70 neonates and their parents | RCT | Bathing with baby shampoo, wet wipes, and emollient cream (zinc oxide and olive oil) vs. no skin care for 4 weeks after birth | Incidence of DD: 11.4% (intervention group) vs. 57.1% (control group) | Not reported |
| Yonezawa et al. (2018) (22) | Japan | 227 neonates 1 week to 3 months old | RCT | Bathing every 2 days and using emollients daily vs. daily bath without emollients | Lower TEWL and DD incidence with emollient use | Not reported |
| Yuan et al. (2018) (23) | China | 211 children 3 to 24 months old without rash or with mild rash (DD criteria score: 0–2) | RCT | Diapers with the latest materials vs. standard diapers | Diapers with the latest materials significantly reduced DD compared to standard diapers. | No side effects in any of the subjects |
| Gustin et al. (2020) (24) | US | 38 children 7 months to 2 years old | RCT | Diapers containing emollients and wet wipes with buffers vs. diapers without emollients and wet wipes with limited buffering capability | Emollient-containing diapers and buffered wet wipes preserved skin pH, reduced enzymatic activity, and prevented DD. | Not reported |
| Price et al. (2020) (25) | England | 722 children 1 day to 8 weeks old | Quasi-experimental | Use of wet wipes from three different brands | Minimal-ingredient wipes had the lowest DD rates, the shortest duration of DD, and milder manifestations of DD. | Not reported |
| Dall'Oglio et al. (2021) (2) | Italy | 10 children 1 day to 4 years old with mild to moderate DD | Quasi-experimental | Mild cleanser, superabsorbent diaper, and protective cream containing zinc gluconate taurine complex, zinc oxide, panthenol, glycerin, and shea butter for 30 days | There was a significant decrease in the erythema scale in the diaper area on day 30. | Not reported |
| Gustin et al. (2021) (26) | US | 90 infants 8 days to 8 weeks old | RCT | Use of disposable diapers with apertures and containing emollients, along with wet wipes with an acidic pH, vs. disposable diapers without apertures and emollients, and non-buffered wet wipes | Diapers with emollients and acidic wipes maintained acidic pH, reduced severe erythema episodes, and lowered DD incidence. | No side effects related to the intervention provided |

**Table 1** | **Continued.**

| Author (year) | Country | Subjects | Study design | Therapy/prevention | Efficacy | Side effects |
|---|---|---|---|---|---|---|
| Peltier et al. (2023) (16) | Switzerland | 564 children 0 to 24 months old with DD that used dexpanthenol ointment | Retrospective cohort | 5% dexpanthenol ointment | 83% showed clinical improvement within 1 day, and 78% achieved complete resolution within 2 days of dexpanthenol use. | Uncomfortable sensation |
| Başkale et al. (2024) (27) | Turkey | 48 pairs of children (6 to 18 months old) and their mothers | Quasi-experimental | Topical hindmilk applied to the diaper area after each diaper change for 2 weeks | Topical breast milk in the diaper area resulted in a lower incidence of DD. | No subjects experienced any side effects. |

NICU = neonatal intensive care unit, RCT = randomized controlled trial, TEWL = transepidermal water loss, DD = diaper dermatitis.