



Jornal de Pediatria

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ORIGINAL ARTICLE

Q1 Cloth versus disposable diapers: an exploratory study on family habits

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Received 11 March 2024; accepted 15 October 2024

Available online xxx

KEYWORDS

Diapers;
Diaper rash;
Cloth diaper;
Disposable diaper;
Dermatitis;
Contact dermatitis

Abstract

Objective: To describe features and habits of diaper area care and compare the frequency of diaper dermatitis in infants using cloth diapers with those using disposable diapers.

Methods: Questionnaires were administered to families with infants who had not started potty training, to assess the frequency of diaper rash in two groups: babies who use exclusively cloth diapers (CD), and others with exclusively disposable diapers (DD). The hygiene methods of the perineal region and the skin lesions frequency were evaluated. The study was approved by the Ethics Committee.

Results: 1389 participants were included, 53% male, with a median age of 16 (7–24) months, 1269 (91.4%) in DD and 120 (8.6%) in CD. Mild diaper rash occurred a few times a year in 47.0% and 47.5% in the DD and CD groups, respectively ($p = 0.47$). Severe diaper rash occurred a few times a year in 13% and 10.7% in the DD and CD groups, respectively ($p = 0.66$). In the DD, the most used hygiene method was wet wipes (61.5%), whereas in the CD it was cotton/cloth with water (62.2%; $p < 0.001$).

Conclusion: Disposable diapers continue to be more used; hygiene habits differ between the groups and the use of cloth diapers did not increase the frequency of diaper dermatitis when compared to the use of disposable diapers.

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1 Introduction

2 One of the challenges experienced by families is the occur-
3 rence of dermatitis in the diaper region, which can be
4 caused by primary irritant dermatitis, allergic contact der-
5 matitis and fungal infections. The former is the most com-
6 mon and its main trigger is the contact of urine and feces
7 with the skin,¹ so adequate cleaning, frequent changes and

8 the use of absorbent diapers that minimize skin contact with
9 excreta are essential to avoid changes to the skin barrier in
10 this region, which culminates in diaper dermatitis.²

11 Diapers made of different materials have been part of
12 global culture for years.³ Disposable diapers are the most
13 used in most countries, but they generate a large volume of
14 non-compostable and non-biodegradable waste.

15 Cloth diapers have been adopted by many families around
16 the world, whether for environmental or health reasons. In
17 the past, reusable diapers caused more severe and frequent
18 irritant dermatitis in the diaper area.⁴ However, with the

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<https://doi.org/10.1016/j.jpmed.2024.10.008>

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19 technological evolution of fabrics and models, it is possible
20 that this paradigm has changed.

21 There is a lack of comparative studies on different types of
22 diapers and their impact on the frequency of diaper dermatitis.
23 Therefore, doctors and families have little scientific informa-
24 tion to decide which type of diaper to use. The present study
25 aimed to describe features and habits of diaper area care and
26 compare the frequency of diaper dermatitis in infants using
27 cloth diapers with those using disposable diapers.

28 Methods

29 The study was analytical and observational, with prospective
30 data collection, approved by the institution's Human Research
31 Ethics Committee (CAAE 57591022.5.0000.0096). Data collec-
32 tion took place from January to March 2022, with a research
33 instrument sent via Google Forms® and prepared by the
34 researchers. All participants signed an Informed Consent Form.

35 It included parents of children aged 5 years or less from
36 any Brazilian state or Brazilians living abroad, who had not
37 started the potty-training process and, therefore, used dia-
38 pers daily. Participants who did not answer >50% of the
39 questions in the research instrument, and those with chil-
40 dren over the age of 5, were excluded.

41 The research was publicized by the authors through the
42 social media Instagram® and WhatsApp®. Participants were
43 directed to 2 links: containing a questionnaire – one for the
44 group that exclusively used disposable diapers, and another
45 for those who used exclusively cloth diapers. After 60 days,
46 information from the questionnaires (in Google Forms®) was
47 extracted into Microsoft Excel® spreadsheets.

48 The diaper dermatitis diagnosis was based on parents'
49 reports of mild or severe diaper rash injuries per year. Demo-
50 graphic information such as age, sex, and perineal hygiene
51 habits, number of diaper changes, hygiene method, and use of
52 diaper rash prevention ointments. A detailed description of
53 the questionnaire is provided in the Supplementary Material.

54 Data were analyzed with the Statistica 4.0 Program (Stat-
55 Soft Power Solutions, Inc., Palo Alto, California, USA). Continu-
56 ous variables are expressed as mean (standard deviation)
57 and median (interquartile range), while categorical variables
58 are expressed in their absolute and relative frequencies. To
59 estimate the difference between continuous variables of an
60 asymmetric nature, the Mann-Whitney test was applied,
61 while for categorical variables, the Pearson chi-square test
62 was applied. The multivariate logistic regression model was
63 applied to estimate the main factors associated with mild and
64 severe diaper dermatitis, also illustrated in Forest Plot
65 graphs. Residual deviation graphs indicated a homogeneous
66 distribution, pointing to a well-adjusted model. The maxi-
67 mum value of the variance inflation factors (VIF) was 3, indi-
68 cating the absence of multicollinearity. The univariate
69 logistic regression model was used to estimate the association
70 between the probability of mild diaper dermatitis and age.

71 Results

72 The study population comprised 1620 participants, of which
73 1605 met the inclusion criteria. Two hundred and sixteen
74 were excluded, with a final sample of 1389 cases, among

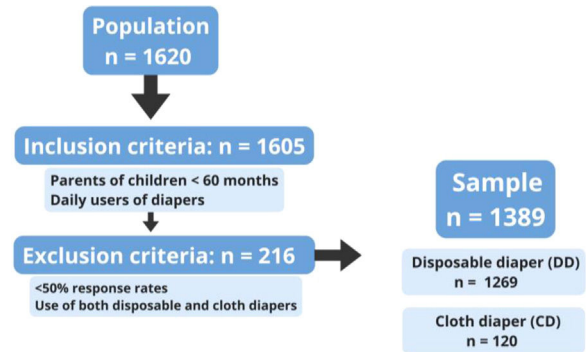


Figure 1 Diagram with number of participants in each group. DD, Disposable diaper group. CD, Cloth diaper group.

75 them, 1269 children (91.4%) used disposable diapers (DD),
76 and 120 (8.6%) used cloth diapers (CD) (Figure 1).

77 The median age of the participants was 16 months
78 (IQR = 7–24 months), more precisely 16 months (IQR = 8–24)
79 for the DD group and 13 months (IQR = 5–22) for the CD group
80 ($p = 0.03$), with approximately 53.0% of males in both groups
81 ($p = 0.94$).

82 Around 80% of the children used 5 to 8 diapers a day,
83 ranging from 1 to 20 for the DD and 1 to 15 for the CD group
84 ($p = 0.52$).

85 Regarding the cleaning method during diaper changes, in
86 the DD there was a predominance of the use of wet wipes
87 (61.5%), while in the CD the use of cotton or cloth and water
88 (62.2%) prevailed ($p < 0.001$).

89 Barrier ointments were used by 68% of children in the DD
90 and 26.3% in the CD (in some or all diaper changes); and in
91 28.7% of the DD and 59.7% of the CD they were used only in
92 the presence of diaper rash ($p < 0.001$) (Table 1A).

93 In the multivariate analysis to identify predictive factors
94 for mild diaper dermatitis, it was observed that age below
95 24 months increased the risk of diaper dermatitis by twofold
96 (OR = 1.92, 95% CI = 1.39–2.66, $p < 0.001$). For severe dia-
97 per dermatitis, the same factor was observed, with a five
98 times higher risk associated with age (OR = 5.40, 95%
99 CI = 0.68–42.30, $p = 0.04$) (Table 1B) (Figure 2).

100 Mild diaper rash occurred a few times a year in 47.0% and
101 45.4% in the DD and CD groups, respectively ($p = 0.47$).
102 Severe diaper rash occurred a few times a year in 13.1% and
103 7.6% in the DD and CD groups, respectively ($p = 0.66$). No sig-
104 nificant difference was observed in the frequency of mild
105 ($p = 0.23$) or severe ($p = 0.44$) diaper dermatitis between the
106 study groups (Figure 2).

107 Discussion

108 Cloth diapers have been used for infants for centuries, with
109 the most diverse fabrics.³ In the 20th century, disposable
110 diapers began to be produced and improved, making fami-
111 lies' routines easier. From 1960 onwards, disposable diapers
112 replaced cloth diapers.⁵

113 Disposable diapers are made of synthetic materials such
114 as polypropylene and polyethylene, elastics, and adhesives.
115 The inner layer is made of cellulose and absorbent polymer
116 (polyacrylamide and/or sodium polyacrylate) which, when
117 absorbing urine, forms a gel, preventing the liquid from

Q3 Table 1 Cleaning methods and use of barrier ointments (A); Multivariate logistic regression for risk factors for diaper dermatitis (B).

Cleaning methods Use of barrier ointments	DD (n = 1269)	CD (n = 120)	p
Cleaning method			
Only cotton/ cloth and water	426 (37.4%)	61 (62.2%)	< 0.001
Only wet wipes	700 (61.5%)	29 (29.6%)	
Both	13 (11%)	8 (8.2%)	
Barrier ointments			
Never	3.4%	14.1%	< 0.001
Only if rash	28.7%	59.7%	
In some diaper changes	39.0%	21.2%	
In all diaper changes	29.0%	5.1%	

Factors	Mild diaper dermatitis			Severe diaper dermatitis		
	OR	IC 95%	p	OR	IC 95%	p
Sex	1.00	0.78–1.28	0.96	2.56	0.89–7.29	0.07
Age (months)	1.92	1.39–2.66	<0.001	5.40	0.68–42.30	0.04
Type of diaper	1.06	0.66–1.70	0.79	0.86	0.17–4.30	0.86
Number of diaper/ 24h	1.18	0.94–1.48	0.14	0.85	0.35–2.08	0.73
Wet wipes	1.16	0.92–1.48	0.19	0.51	0.20–1.32	0.17
Barrier ointments	0.96	0.72–1.26	0.77	0.72	0.25–2.02	0.53

Pearson chi-square test.

118 returning to contact with the skin, without exaggerated
119 increase in size (contributing to the infant's comfort).
120 Optionally, their material may be impregnated by lotions
121 that are released onto the skin after contact, promoting
122 hydration and improving the skin barrier.^{5,6}

123 Although disposable diapers are still the most frequent
124 choice for families, cloth diapers have been increasingly
125 used, whether for cost reasons or environmental concerns.

126 Current cloth diapers are made up of layers.⁷ The top
127 layer (in contact with the skin) is made up of fabrics that are
128 permeable to urine (e.g. microfleece or suede), but do not
129 retain moisture. To keep the skin dry, there is an absorbent
130 internally positioned, usually made of melton (approx-
131 imately 80% cotton and 20% polyester) or microfiber, in
132 layers, adjusted to the size of the diaper pocket. Absorbents
133 allow the diaper to be used for some hours, keeping the skin
134 dry. The (outer fabric is a waterproof, breathable, and flexi-
135 ble cover, usually made of laminated polyurethane, lycra,
136 tactel, or other fabrics. The cover is closed with adjustable
137 buttons or velcro, which fits infants weighing 3 to 16–20 kg,
138 so it can be used from newborns to potty training. The cloth
139 diaper exemplified in Figure 3 is the “pocket” or “pocket/
140 cover” type and is commonly used. There are other composi-
141 tions, such as “all-in-one”, made with similar fabrics, but
142 with the absorbent sewn into the inside of the diaper, in
143 direct contact with the skin and which cannot be removed
144 for washing (Figure 3).

145 After the feces have been removed, the ecological dia-
146 pers can be machine-washed with regular soap. Drying is
147 preferably done in the sun, ironing or tumble drying are not
148 recommended. There is no need to wash dirty eco-friendly

149 diapers daily. It is possible to store them in a waterproof bag
150 or bucket with a lid for washing after a few days. To facili-
151 tate the removal of feces, disposable wipes called liners can
152 be used between the skin and the diaper. They are generally
153 biodegradable and can be disposed of along with feces in the
154 toilet.

155 Cloth diapers in pediatric care have some disadvantages.
156 They may require more frequent changes, when compared
157 to disposable diapers, to prevent urine and stool leakages,
158 depending on the number of absorbent cloth layers used.
159 Thorough cleaning and sanitization are necessary to avoid
160 bacterial contamination and reduce odor, potentially
161 increasing parental workload.³

162 Diaper dermatitis is an irritant contact dermatitis on the
163 perineal skin of newborns or infants. It is determined by con-
164 tact with urine and feces in a constantly humid environment
165 and under occlusion (diapers).¹ It is not an allergic contact
166 dermatitis to the type of diaper. Diaper dermatitis is identi-
167 fied as an erythema in the perianal, vulvar and thigh region -
168 often sparing the inguinal folds - and is more common in
169 infants aged 6 months to 2 years.⁴ Skin irritation is caused by
170 an increase in the pH of the skin, caused by an increase in
171 the activity of enzymes that convert urea into ammonia,
172 and skin friction during hygiene when changing diapers is a
173 worsening factor.⁵

174 The increase in the frequency of use of disposable diapers
175 over the years has been related to a significant reduction in
176 the incidence of diaper dermatitis, a fact attributed to
177 absorbent materials that reduce the contact of excreta with
178 the skin,⁵ although there is no proof of the greater effective-
179 ness of one or another diaper material.⁸

Figure 2A. Frequency of mild and severe diaper dermatitis according to study groups.

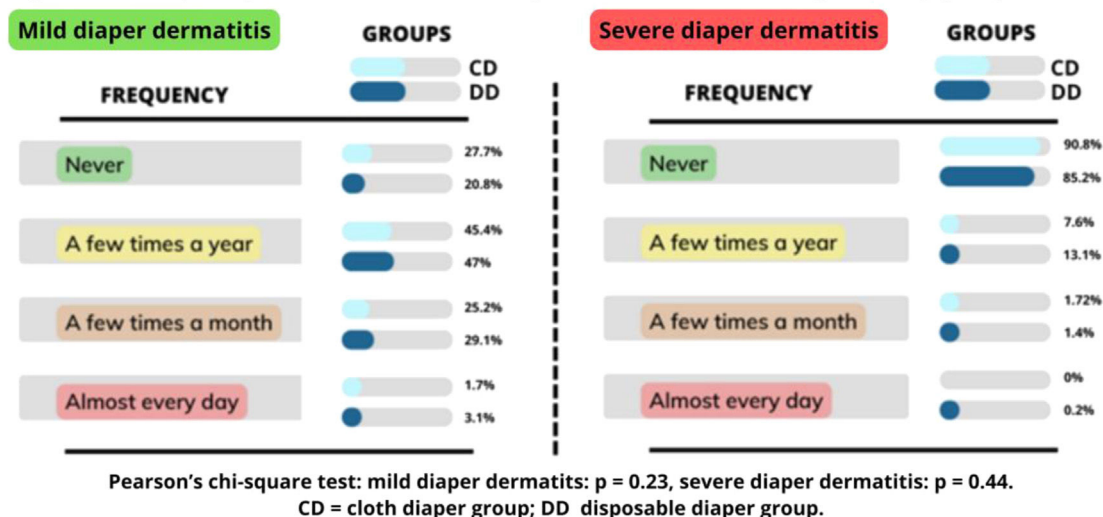


Figure 2B. Risk factors for mild and severe diaper dermatitis.

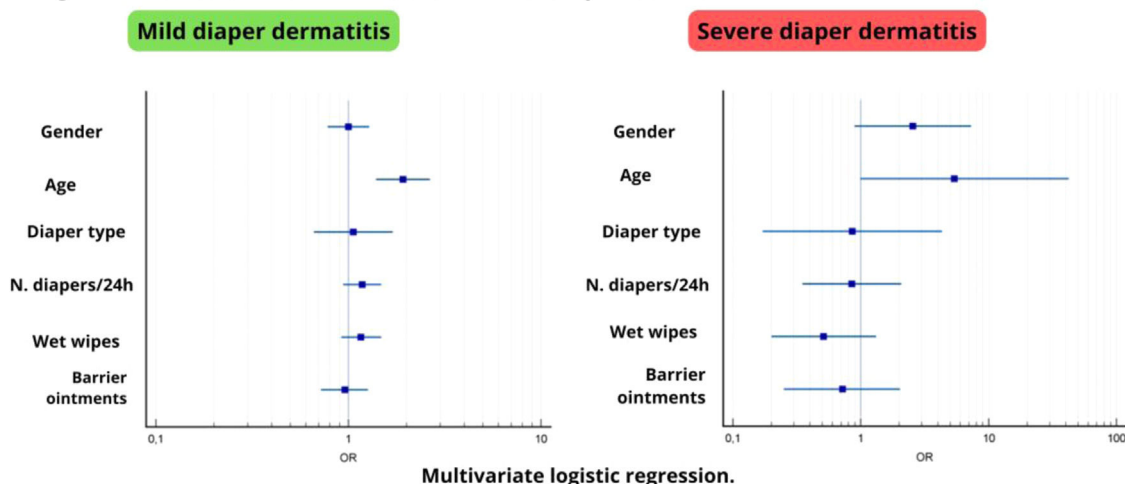


Figure 2 Frequency of Mild and Severe diaper dermatitis (A); Forest plot of risk factors for mild and severe diaper dermatitis (B). DD, Disposable diaper group; CD, Cloth diaper group.

180 There are cases of diaper dermatitis with the use of the
 181 old types of cloth diapers.⁵ Harfmann et al., 2017, reported
 182 4 infants using cloth diapers, without specifying the type,
 183 with vesico-bullous lesions in the perineal region that were
 184 refractory to usual treatments for diaper dermatitis, and
 185 that improved with the change to disposable diapers or potty
 186 training.⁹ In 1982, Stein and Brook evaluated 200 infants in a
 187 controlled and blind manner, divided into 4 groups: 1 using
 188 common cloth diapers (without specifying the type of fabric)
 189 with domestic washing, and another 3 using disposable di-
 190 pers. The incidence of diaper dermatitis in the cloth diaper
 191 group was higher.¹⁰ Babu et al., 2015, evaluated 253 babies
 192 in a neonatal intensive care unit divided into 2 groups – one
 193 using 3-layer disposable diapers, the other using cotton di-
 194 pers as a single layer (white cotton fabric folded in a triangu-
 195 lar shape). The disposable diaper group had a significant
 196 reduction in the incidence of probable sepsis. However, this
 197 study considered the use of reusable diapers made with only
 198 one layer of cotton, as a single fabric,⁹ different from the

reusable diapers currently used, composed of more than one
 fabric and layer.

Liu et al., 2011, from the company Procter and Gamble,
 described an evaluation carried out by nurses including 694
 Chinese children using traditional cloth diapers exclusively
 (single fabric held on the participant by an elastic band).¹¹
 The intention of using this type of diaper in the Chinese pop-
 ulation is to indicate that there has been urination or evacu-
 ation for an immediate diaper change, so waterproof
 materials are not commonly used. Therefore, diaper
 changes during the day and night are more frequent with
 Chinese cloth diapers. Healthy babies aged 3 to 9 months
 using exclusive diapers, at least in the last 7 days, were
 included. Sixty percent of the infants had undergone at least
 3 diaper changes the night before the visit. There was no
 rash or redness on the skin of the genital region and buttocks
 in 76.5% of the infants, but 51.4% had lesions in the intertri-
 ginous areas and 70.6% had some degree of perianal derma-
 titis. The authors concluded that this type of diaper does



Figure 3 Image showing a cloth diaper diagram. Image authorized by the manufacturer, who kindly provided the cloth diaper, Malana Eco®.

218 not increase the frequency of diaper dermatitis in convex
219 areas, but rather perianal and intertriginous areas.¹¹

220 Maruani et al., 2013, reported 5 infants aged 7 to 17
221 months using reusable diapers for at least 6 months, with
222 severe perineal dermatitis for weeks to months, which
223 improved with the use of disposable diapers and topical
224 treatments.⁴ These patients presented ulcerated or papulo-
225 nodular lesions in the perianal and genital regions (convex
226 regions). In 3 of the 5 cases of skin biopsy, there was nonspe-
227 cific inflammation, such as hyperkeratosis and perivascular
228 inflammatory infiltrate in the superficial dermis. The authors
229 conclude that reusable diapers were less absorbent than dis-
230 posable diapers, which contributed to prolonged contact of
231 the skin in the convex regions with urine and feces. As a
232 result, fecal enzymes damage the skin and alter the pH of
233 the region.⁴

234 A cross-sectional study with 1153 Thai children aged
235 1–24 months, by Sukhneewat et al., identified as significant
236 risk factors for diaper dermatitis: <3 nightly diaper changes,
237 use of cloth diapers (although without specifying the type),
238 use of talcum powder in the diaper region, and previous epi-
239 sodes of diaper dermatitis.¹²

240 Although the cited studies indicate a higher frequency of
241 diaper dermatitis in babies who use reusable diapers, most
242 of them do not consider the new currently used type of reus-
243 able diapers, made up of layers that simulate disposable dia-
244 pers. In the present study, the frequency of diaper rash was
245 similar among infants using cloth and disposable diapers.
246 Another point to consider is that the ED group used diaper
247 rash prevention ointments less frequently than the DD
248 group. Since these ointments help prevent diaper dermati-
249 tis, it is plausible to consider that ecological diapers were

250 more effective than disposable diapers as protective factors
251 against DCD.

252 Regarding the hygiene diaper changing method, it was
253 observed that in the DD group, the wet wipe was the most
254 used. In the CD group, cleaning with cotton/cloth and water
255 was more frequent – which matches the profile of families
256 who seek to use more natural materials and substances on
257 their children's skin. The use of wet wipes can also influence
258 the frequency of diaper dermatitis, since they can contain
259 substances that might irritate the skin, such as alcohol,
260 sodium lauryl sulfate, methylisothiazolinone (MI), methyl-
261 chloroisothiazolinone and perfume.¹³ Even the DD using
262 more wet wipes had diaper dermatitis at the same frequency
263 as the CD, possibly due to using more prevention ointments.
264 These data demonstrate the multifactorial nature of diaper
265 dermatitis and the importance of clarifying all aspects of
266 hygiene and care in the diaper area with the guidance of
267 families.

268 The present study found that for the family profiles
269 included, only an age of <24 months was identified as a sig-
270 nificant risk factor for diaper rash. Other factors such as the
271 use of wet wipes or diaper rash ointments, although showing
272 significant differences in usage frequency between groups,
273 did not have an impact on the incidence of diaper rash. It is
274 important to note that daily care habits for the diaper area,
275 including cleaning methods and skin protection, are influ-
276 enced not only by the objective frequency of diaper rash but
277 also by cultural patterns and personal consumption prefer-
278 ences.

279 Environmentalists argue that reusable diapers are less
280 harmful to the environment.¹⁴ Disposable diapers make up
281 almost 2% of the total weight of urban solid waste generated

282 in Brazil.¹⁵ Besides, during the manufacturing process of dis-
 283posable diapers, plastics, polymers, tapes, elastics, and
 284adhesives are synthetic products produced from naphtha,
 285which is a fraction of petroleum, known as a non-renewable
 286raw material.^{6,15}

287 On the other hand, the disposable diaper industry points
 288out, for example, in a 2011 Procter and Gamble laboratory
 289review, that cloth diapers consume energy, water, detergents,
 290and machinery for their washing and, therefore, their impact
 291is comparable to the impact caused by disposable diapers, dis-
 292carded in the trash.⁵ However, this quote is not based on clear
 293studies that demonstrate this information in numbers.

294 The author Stephen Leahy states, in his book “Your Water
 295Footprint”, 2014, that a disposable diaper consumes an
 296average of 545 liters of water to be produced. If a baby uses
 297approximately 6000 disposable diapers in total, there is a
 298total consumption of 3.27 million liters of water.¹⁴ To pro-
 299duce a cloth diaper, an average of 15 liters is consumed. A
 300common washing machine uses an average of 140 liters per
 301cycle. If used 3 times a week for 3 years, the total water
 302consumption for washing would be 65.5 thousand liters¹⁴ -
 303significantly lower than the consumption generated by dis-
 304posable diapers.

305 The limitations of the present study include differences
 306in the content of the questions between the groups and a
 307possible memory bias due to remote answering of questions.
 308The study also lacked a physical examination, which could
 309have included other diagnoses of diaper area diseases. Addi-
 310tionally, the absence of information on the subject's health,
 311such as illness incidence, could have influenced the inci-
 312dence of diaper rash. The study did not have a consistent
 313pattern in the types of diapers used, which could have
 314affected the frequency of diaper dermatitis. Lastly, there
 315was a significant difference in the number of participants
 316between the groups, with disposable diapers being more
 317commonly used, but the number of exclusively cloth diaper
 318users was remarkable compared to other studies.

319 Cloth diapers currently used by the Brazilian population are
 320effective in containing excreta and reducing their contact with
 321children's skin. They present a risk of diaper dermatitis at a
 322similar frequency to disposable diapers, contrary to what is
 323indicated in the literature based on case reports or studies
 324that do not specify the type of reusable diaper used, or that
 325used old cloth diapers (in a single layer) that do not reduce the
 326contact of urine and feces with the skin.

327 Conflicts of interest

328 The authors declare that the research was conducted with-
 329out any commercial or financial relationships that could be
 330construed as a potential conflict of interest. The study was
 331funded by the Wonderland Foundation, the Gottfried und
 332Julia Bangerter-Rhyner Foundation, and the UniBern
 333Research Foundation.

334 The measurement data would be made available upon
 335request to the authors after a formal data-sharing agree-
 336ment has been reached.

337 The study protocol was approved by the local institu-
 338tional review board (KEK-Bern, BASEC number 2020–02978).

Funding sources

No funding was received to assist in the preparation of this
 manuscript.

Acknowledgments

The authors extend our sincere gratitude to Dr. Mônica
 Nunes Lima for her important contribution to the statistical
 analysis of this study.

Supplementary materials

Supplementary material associated with this article can be
 found in the online version at doi:10.1016/j.jpmed.2024.10.008.

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