

REVIEW

CONTACT
DERMATITIS

WILEY

Hidden risks in toys: A systematic review of pediatric toy contact dermatitis

Justine Fenner¹ | Ali Hadi¹ | Lindsey Yeh¹ | Nanette Silverberg² 

¹Department of Dermatology, Icahn School of Medicine at Mount Sinai, New York, New York

²Department of Dermatology and Pediatrics, Icahn School of Medicine at Mount Sinai, New York, New York

Correspondence

Dr Nanette Silverberg, Chief Pediatric Dermatology, 5 E 98th Street, 5th Floor, New York, NY 10029, USA.
Email: nanette.silverberg@mountsinai.org

Abstract

Toys are a reflection of the compounds used frequently in manufacturing. Allergic contact dermatitis to potties, metal toys, and children's jewelry is well known, however, there is a broad range of skin risks in toys. With the objective to identify and publicize the associated risk of contact dermatitis in children's toys, we have searched the PubMed database from creation to September 9, 2019. Studies were eligible if they reported a new case of contact dermatitis secondary to interaction with a toy in patients from birth to 18 years of age. A toy was defined as something children interact with for entertainment during leisure time. In this review of the PubMed database we filtered by age and language which may have prevented us from detecting cases in adults that could be extrapolated to children. In addition, several articles were excluded based on title alone. A total of 1312 articles were identified and reviewed manually for inclusion criteria. Review of the articles found 25 original articles for consideration. Several toys were found to be associated with contact dermatitis. These included electronics, toy cars, costume jewelry, bicycles, squish balls, slime, Play-Doh, and plasticine. Electronics such as video game controllers, cellphones, iPads, and computers were implicated. In conclusion, there is still an unmet need for observation of this segment of industry for labeling of contents and ongoing surveillance.

KEYWORDS

allergic contact dermatitis, contact urticaria, irritant contact dermatitis, patch test, review

1 | INTRODUCTION

Children's toys have been used to amuse, engage, and educate children since ancient times. In recent years the products have become a reflection of the compounds used frequently in manufacturing, including metals and plastic compounds. Allergic contact dermatitis is increasingly common in children and nickel is the leading cause.¹ Nickel is also becoming increasingly common in toys due to exposure from electronics. Reports of allergic contact dermatitis to potties, metal toys, and children's jewelry are well known, however, there is a broad range of skin risks in children's toys. We performed a systematic review to illustrate the variety of toys involved in pediatric contact dermatitis.

2 | METHODS

This systematic review (Figure 1) was based on the PubMed database with the following search criteria: (dermatitis OR rash OR eczema) AND (toy* OR nintendo OR playstation OR xbox OR fidget spinner OR sticker* OR colored pencil OR papier mache OR modge podge OR volcano OR crayon OR diorama OR putty OR play-doh OR clay OR glue OR sand OR lanyard OR doll OR barbie OR bear OR hot wheels OR fisher-price OR wooden OR game* OR puzzle OR rubix OR slime OR balloon OR costume OR jewelry OR computer OR ipad OR ipod OR iphone OR cellphone OR laptop OR Gameboy OR wii OR robot OR ball OR lego OR Nerf OR bicycle OR tricycle OR scooter OR hoverboard OR trampoline OR airplane OR plane OR train OR car

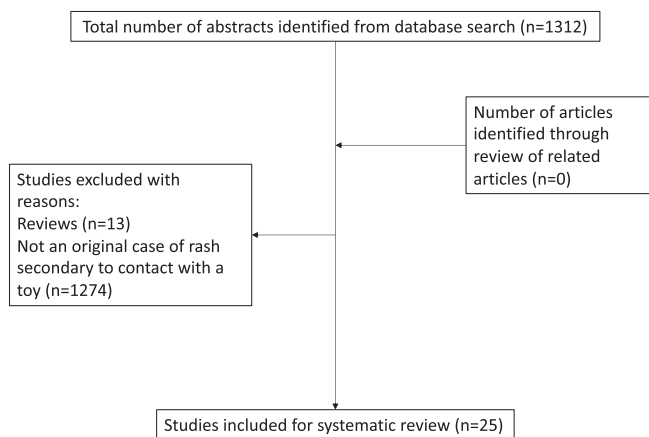


FIGURE 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram

OR paint* OR watercolor OR play OR plaything* OR puppet*). Our search applied filters such that it included all English language articles published in patients from birth to 18 years in the PubMed database from creation to September 9, 2019. A total of 1312 articles were identified from the initial search and were reviewed for the following criteria: reporting of a pediatric case of contact dermatitis and contact dermatitis attributed potentially or directly to a toy with which the pediatric patient played. A toy was defined as something children interacted with for entertainment during leisure time. Pure review articles were reviewed for other primary sources, but otherwise not included. For included articles we collected data on study design, age of patient, sex of patient, suspected toy eliciting contact dermatitis, site of reaction, type of reaction, suspected allergen, and whether the patient underwent patch testing.

3 | RESULTS

After identification of 1312 articles with our initial search criteria, 1203 articles were excluded based on title alone as they were not related to children's toys and/or they did not report children with contact dermatitis. Fifty-one studies were excluded after review of the abstract due to lack of specific identification of cases of contact dermatitis from toys. Twenty additional articles were excluded after review of the full text of the article as the cases cited were not pertinent to toy contact dermatitis. Thirteen studies were excluded because they were pure review articles; however, these studies were reviewed for additional primary references. Following these exclusions, we finally considered 25 original articles that reported contact dermatitis from toy exposure in pediatric patients (Table 1).

Through our review of the literature we were able to find cases of nickel dermatitis in association with many electronic toys that children play with today, including laptops, video-game (Xbox) controllers (Figure 2), iPads, and cellphones (Figure 3).¹⁻⁸ Of the electronics causing contact dermatitis, the most commonly reported culprit was the cell phone. In addition to nickel, chromate was also suspected to play

a role in some cases of cell phone contact dermatitis.⁹ In other cases the exact irritant/allergen in the cellphone could not be elucidated, however discontinuation of the device or use of protective barriers resulted in resolution of the rash.^{10,11} The presentation of cell phone dermatitis ranged from facial dermatitis (cheek and periauricular) to hand dermatitis and even breast dermatitis in a patient who was keeping her cell phone in her brassiere.⁵ In many of these cases, use of patch testing in combination with dimethylglyoxime testing to uncover nickel presence in the suspected product was imperative.

Model cars were also found to be a vehicle for children to come into contact with allergenic metals. Die-cast model cars are made from zinc, aluminum, magnesium, and copper alloy. A 5-year-old boy with recurrent finger dermatitis underwent patch testing and was found to have a strong positive reaction to copper(II) sulfate pentahydrate and a negative reaction to nickel. The source of the copper allergy was believed to be his model cars, and his dermatitis resolved after avoiding the metal cars.¹²

Children were also found to come in contact with allergenic metals by way of costume jewelry. A 9-year-old female who was "addicted" to costume jewelry was found to have lichenified plaques of the hands, antecubital arms, and perioral region. Her patch test was strongly positive to nickel (+++), gold thiosulfate (++), and thiurams (+++).¹³ In addition to causing contact dermatitis to metals, jewelry can contain wood, latex, rubber, plastics, and dyes that can cause contact dermatitis. Furthermore, ceramic- or pottery-containing jewelry can contain allergenic chromates, turpentine, and other metals.¹³

Skin adornment with temporary tattoos was another source of toy dermatitis discovered in this review. One case was found in which a 4-year-old male patient was found to have an irritant reaction to a Halloween-themed temporary tattoo.¹⁴ After several hours of wearing the temporary tattoo the patient, and his mother, developed mild erythema and a pruritic papule beneath the tattoo. This resolved over 4 days without the need for treatment. The causative agent could not be discovered with inspection of the packing materials.

Bicycles are another possible source of dermatitis in children. A 10-year-old nonatopic Turkish boy was found to have vesicular bilateral palmar dermatitis after intensive use of his new bicycle. After patch testing it was discovered he had a strong positive reaction to *N*-isopropyl-*N'*-phenyl-*p*-phenylenediamine, the main sensitizer in black rubber. When he stopped riding his bicycle the rash resolved completely.¹⁵

More recently, several case reports have been published reporting contact dermatitis to homemade "slime."¹⁶⁻²¹ Slime is a popular plaything made at home with combinations of borax, household detergents, bleach, glue, shaving cream, and colorings/dyes.²⁰ In 2017, borax-containing slime "recipes" were reported to cause second- and third-degree burns. As a result, there was a surge in borax-free slime recipes that were considered to be safe.¹⁸ Unfortunately, the other components of slime can contain contact allergens (Figure 4). For example, glue can contain methylchloroisothiazolinone/methylisothiazolinone (MCI/MI, eg, Kathon CG) and shaving cream may contain sodium lauryl sulfate, both known contact allergens and irritants, respectively.^{17,21}

TABLE 1 Table summarizing findings of articles included for review

Reference number	Author year	Study type	Age (y)	Sex	Suspected toy	Site of reaction	Type of reaction	Suspected allergen	Suspected allergen confirmed by patch testing?
1	Abbas et al (2018)	Case report	12	M	Computer desk hardware leaned on while playing "Minecraft"	Right volar forearm	Eczematous	Nickel	Yes
2	Jacob and Admani (2014)	Case report	11	M	MacBook Pro laptop	Generalized	Eczematous	Nickel	Yes
3	Jacob and Admani (2014)	Case report	11	M	iPad	Generalized	Eczematous	Nickel	Yes
4	Jacob (2014)	Case report	9	M	Xbox controller	Not discussed	Not discussed	Nickel	Yes
5	Suarez et al (2011)	Case report	14	F	Cell phone	Periumbilical and intramammary	Eczematous	Nickel	Yes
6	Berk et al (2011)	Case series	12	M	Cell phone	Right face and neck	Eczematous	Nickel	Not discussed
			14	F	Cell phone	Left face	Eczematous	Nickel	Not discussed
			16	F	Cell phone	Bilateral face	Eczematous	Nickel	Not discussed
			17	F	Cell phone	Bilateral face	Eczematous	Nickel	Not discussed
			18	M	Cell phone	Right cheek	Eczematous	Nickel	Not discussed
7	Moennich et al (2009)	Cases series	13	F	Cell phone	Unilateral face	Eczematous	Nickel	Yes
			15	F	Cell phone	Unilateral face	Eczematous	Nickel	Yes
			18	F	Cell phone	Unilateral face	Eczematous	Nickel	Yes
8	Luo and Bercovitch (2008)	Case report	18	M	Cell phone	Lower abdomen, extremities, flanks, face	Eczematous	Nickel	Yes
9	Seishima et al (2003)	Case series	14	M	Cell phone	Preauricular	Eczematous	Chromate	Yes
			18	M	Cell phone	Preauricular	Eczematous	Chromate	Yes
10	Ward and Cox (2017)	Case report	6	F	Cell phone	Lateral one-third of the palm of the left hand, including the first through third digits and the right index finger	Eczematous	Unknown	Not discussed
11	Valdivieso et al (2013)	Case report	15	F	Cell phone	Cheeks and chin	Eczematous	Unknown	Reaction to mobile phone screen and extract prepared from screen
12	Walker-Smith et al (2016)	Case report	5	M	Die-cast model cars	Fingertips	Eczematous	Copper	Yes
13	Silverberg (2016)	Case report	9	F	Costume jewelry	Lips, perioral, fingertips, dorsal hands, antecubital arms	Eczematous	Nickel, gold, thiuram	Yes
14	Couzin-Frankel (2018)	Case report	4	M	Temporary tattoo	Not discussed	Eczematous	Unknown	Not discussed

(Continues)

TABLE 1 (Continued)

Reference number	Author year	Study type	Age (y)	Sex	Suspected toy	Site of reaction	Type of reaction	Suspected allergen	Suspected allergen confirmed by patch testing?
15	Özkaya and Elinc-Aslan (2011)	Case report	10	M	Bicycle	Flexural fingers and palms	Eczematous	Black rubber	Yes
16	Aerts et al (2018)	Cases series	11	F	Slime	Palms	Eczematous	MCI/MI	Yes
			9	M	Slime and/or play-gel (by Play-Doh [Hasbro])	Hands	Eczematous	MCI/MI and parabens	Yes
17	Gittler et al (2018)	Case report	9	F	Slime	Hands	Eczematous	Not discussed	Not discussed
18	Heller et al (2019)	Cases series	7	F	Slime	Palms	Eczematous	Not discussed	Not discussed
			10	F	Slime	Palms	Eczematous	Not discussed	Not discussed
19	Kondratuk and Norton (2019)	Case series	12	F	Slime	Dorsal right hand	Eczematous	Not discussed	Not discussed
			13	F	Slime	Palms	Eczematous	Not discussed	Not discussed
20	Piazza and Cestari (2018)	Case report	11	F	Slime	Dorsal aspect of six fingers	Eczematous	Not discussed	Not discussed
21	Zhang et al (2019)	Case report	10	F	Slime	Distal dorsal and palmar fingers	Eczematous	MCI/MI	Yes
22	Tosti et al (1990)	Case series	7	F	Plasticine	Palms, interdigital spaces of hands, back of the left hand	Eczematous	Kathon CG and 2-chloro-N-methyl-chloroacetamide	Yes
			3	F	Plasticine	Hands and face	Eczematous	Kathon CG and 2-chloro-N-methyl-chloroacetamide	Yes
23	Baron and Moss (2004)	Case report	3	M	Play dough	Forearms	Urticarial	Dyes E124 and E129	Yes
24	Ducharme et al (2018)	Case report	7	M	Noise putty	Fingertips	Eczematous	MCI/MI	Yes
25	Brodell and Torrence (1992)	Case report	10	F	Squish ball or cleaning detergent	Dorsal hands and palms	Eczematous	Diisobutyl phthalate	Not discussed

Abbreviations: F, female; M, male; MCI/MI, methylchloroisothiazolinone/methylisothiazolinone (trademark eg Kathon CG).



FIGURE 2 Six-year-old with nickel allergic contact dermatitis from a game console

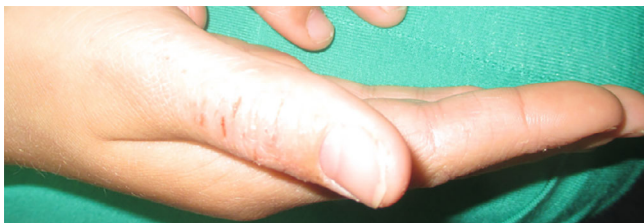


FIGURE 3 Thirteen-year-old male found to have positive reaction to nickel in metal cell phone case on patch testing

Similar products that can be purchased at toy stores have demonstrated contact dermatitis even prior to the slime craze. Tosti et al reported in 1990 two patients who had allergic contact dermatitis to plasticine, a soft modeling material frequently played with by children. After patch testing it was discovered that both patients had a positive reaction to Kathon CG and 2-chloro-*N*-methyl-chloroacetamide. Upon inquiring the manufacturer it was discovered that the plasticine contained both Kathon CG and 2-chloro-*N*-methyl-chloroacetamide.²² In addition, a 3-year-old male patient was demonstrated to have contact urticaria after playing with “Play-Doh.” The culprit allergens were believed to be the dyes E124 (Ponceau 4R, Cochineal Red A) and E129 (Allura Red AC) after patch testing. This then had ramifications regarding whether the patient would be able to consume these dyes in foods and



FIGURE 4 Slime-associated contact dermatitis from a borax-based slime recipe in a girl with a henna tattoo

medications.²³ In a similar case, a 7-year-old male patient with eczema of the fingertips for 1 year was found to have an allergy to his “noise putty.” Noise putty is a play-gel, popular among children, that makes entertaining flatulent sounds. After patch testing, he was found to have a strong positive reaction to MCI/MI and the manufactured “noise putty.” With the help of poison control, it was discovered that the noise putty contained MCI/MI.²⁴ Lastly, a 10-year-old girl was found to have irritant contact dermatitis of the hands after opening a “squish ball” with scissors. In this case it was unclear whether the eruption was secondary to contact with diisononyl phthalate, one of the ingredients of the squish ball core material, or as a result of the efforts to scrub the sticky material from her hands.²⁵

4 | DISCUSSION

Allergic contact dermatitis in children is increasingly common and nickel is the leading cause of allergic contact dermatitis in children.²⁶ Frequent exposure to nickel in toys can elicit cutaneous nickel allergies.²⁷ Jensen et al tested 212 toys purchased in the United States and Denmark for nickel and found that 73 toys (34.4%) released nickel.²⁸ With the advancement in technology there has been a shift in the types of toys children play with and as a result there has been an increasing number of adverse skin reactions to electronics.²⁹ We

found that exposure to metal by way of electronics and toys was a common cause of allergic contact dermatitis; however, squish balls and temporary tattoos were seen to cause irritant contact dermatitis in some cases. Furthermore, slime contains both allergens and irritants with the potential to cause contact dermatitis. The identification of true allergic contact dermatitis in these settings requires both identification of the chemical contents of toys, which are proprietary in nature, and then epicutaneous allergy testing of these ingredients.

Overall, it is a rare occurrence for a toy product to be removed from the market due to skin irritation or allergy. Upon review of the Consumer Product Safety Commission website, only two children's toys were recalled due to skin reactions in the past 5 years. In August 2015 a children's "light up" watch was recalled for a risk of skin irritation, redness, rashes, and chemical burns when the interior of the watch was exposed to water.³⁰ In August 2016, a McDonald's step counting watch served with happy meals was recalled because the wrist bands were causing skin irritation and burns to children.³¹

Our review was limited by both the filtering of articles by age and by language. If we expanded our search to all ages, we may have found reports in adults that could be extrapolated to affect children as well; however, in this review we only focused on reactions that had been reported in children. In addition, by eliminating non-English articles we were unable to include seemingly relevant cases in which the English titles implied rash to a latex balloon and to a Gameboy device. Furthermore, in an effort to retrieve as many articles as possible, our search terms drew a large amount of irrelevant papers. As this was the case, several (n = 1203) were excluded based on title alone. This may have resulted in the exclusion of articles that were in fact relevant.

Through this review we have demonstrated the variety of toys capable of eliciting an undesired cutaneous reaction in children. It should be noted that in many of the cases discussed, the time to diagnosis varied from months to years. This is likely due to the unique triggers involved in precipitating the dermatitis. As dermatologists it is important to keep in mind contact dermatitis when a patient comes in with a bilateral hand rash or a geometric rash. Besides, it may be useful, as it was in several of the aforementioned cases, to have the patient bring in his or her favorite toys for the dermatologist to examine and help further understand the etiology of patient's rash. There is an unmet need for corporations to reveal the chemical ingredients of their toys when allergic contact dermatitis is suspected in order to properly evaluate the patient.

5 | CONCLUSION

While there is low reporting of toy-related skin reactions in children and generally these products are safe, there appears to be the presence of unregulated ingredients in some children's toys, especially those targeted toward school-aged and middle-school children. In order to limit contact dermatitis, regulation of contents of consumer goods, including toys, has proven to be beneficial. There is still an

unmet need for observation of this segment of the industry for both labeling of contents including nickel and ongoing surveillance, particularly to reduce inclusion of potentially allergenic products.

CONFLICT OF INTERESTS

The authors declare they have no conflicts of interest in the production of this work.

ORCID

Nanette Silverberg  <https://orcid.org/0000-0002-4274-7597>

REFERENCES

1. Abbas M, Fiorillo L, Elliott JF. Right forearm eruption associated with playing Minecraft: a case of contact dermatitis related to computer gaming. *J Cutan Med Surg*. 2018;22(2):234-235.
2. Jacob SE, Admani S. Allergic contact dermatitis to a laptop computer in a child. *Pediatr Dermatol*. 2014;31(3):345-346.
3. Jacob SE, Admani S. iPad – increasing nickel exposure in children. *Pediatrics*. 2014;134(2):e580-e582.
4. Jacob SE. Xbox – a source of nickel exposure in children. *Pediatr Dermatol*. 2014;31(1):115-116.
5. Suarez A, Chimento S, Tosti A. Unusual localization of cell phone dermatitis. *Dermatitis*. 2011;22(5):277-278.
6. Berk DR, Bayliss SJ. Cellular phone and cellular phone accessory dermatitis due to nickel allergy: report of five cases. *Pediatr Dermatol*. 2011;28(3):327-331.
7. Moennich JN, Zirwas M, Jacob SE. Nickel-induced facial dermatitis: adolescents beware of the cell phone. *Cutis*. 2009;84(4):199-200.
8. Luo J, Bercovitch L. Cellphone contact dermatitis with nickel allergy. *CMAJ*. 2008;178(1):23-24.
9. Seishima M, Oyama Z, Oda M. Cellular phone dermatitis with chromate allergy. *Dermatology (Basel, Switzerland)*. 2003;207(1):48-50.
10. Ward A, Cox J. Case 4: prolonged and intensely pruritic rash on the hand of a 6-year-old girl. *Pediatr Rev*. 2017;38(2):97.
11. Valdivieso R, Heras-Mendoza F, Conde-Salazar L. Facial contact dermatitis and the irritant potential of mobile phone screens. *Pediatr Dermatol*. 2013;30(6):e177-e179.
12. Walker-Smith PK, Keith DJ, Kennedy CT, Sansom JE. Allergic contact dermatitis caused by copper. *Contact Dermatitis*. 2016;75(3):186-187.
13. Silverberg NB. The "jewelry addict": allergic contact dermatitis from repetitive multiple Children's jewelry exposures. *Pediatr Dermatol*. 2016;33(2):e103-e105.
14. Couzin-Frankel J. Sticker shock. *Science (New York, NY)*. 2018;359(6382):1348-1349.
15. Özkaya E, Elinc-Aslan MS. Black rubber sensitization by bicycle handgrips in a child with palmar hyperhidrosis. *Dermatitis*. 2011;22(4):E10-E12.
16. 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.
17. Gittler JK, Garzon MC, Lauren CT. "Slime" may not be so benign: a cause of hand dermatitis. *J Pediatr*. 2018;200:288.
18. Heller E, Murthy AS, Jen MV. A slime of the times: two cases of acute irritant contact dermatitis from homemade slime. *Pediatr Dermatol*. 2019;36(1):139-141.
19. Kondratuk KE, Norton SA. "Slime" dermatitis, a fad-associated chronic hand dermatitis. *Pediatr Dermatol*. 2019;36(1):e39-e40.
20. Piazza CD, Cestari SCP. Contact dermatitis from Do-It-Yourself slime. *An Bras Dermatol*. 2018;93(6):944.
21. Zhang AJ, Boyd AH, Asch S, Warshaw EM. Allergic contact dermatitis to slime: the epidemic of isothiazolinone allergy encompasses school glue. *Pediatr Dermatol*. 2019;36(1):e37-e38.

22. Tosti A, Bassi R, Peluso AM. Contact dermatitis due to a natural plasticine. *Contact Dermatitis*. 1990;22(5):301-302.
23. Baron SE, Moss C. Contact urticaria to play dough: a possible sign of dietary allergy. *Br J Dermatol*. 2004;151(4):945-947.
24. Ducharme O, Labadie M, Briand SM, Milpied B. Allergic contact dermatitis in a child caused by isothiazolinones in a "noise putty". *Contact Dermatitis*. 2018;79(6):393-394.
25. Brodell RT, Torrence BP. Squish ball dermatitis. *J Am Acad Dermatol*. 1992;26(4):641-642.
26. Jacob SE, Goldenberg A, Pelletier JL, Fonacier LS, Usatine R, Silverberg N. Nickel allergy and our Children's health: a review of indexed cases and a view of future prevention. *Pediatr Dermatol*. 2015;32(6):779-785.
27. Hsu JW, Jacob SE. Children's toys as potential sources of nickel exposure. *Dermatitis*. 2009;20(6):349-350.
28. Jensen P, Hamann D, Hamann CR, Jellesen MS, Jacob SE, Thyssen JP. Nickel and cobalt release from children's toys purchased in Denmark and the United States. *Dermatitis*. 2014;25(6):356-365.
29. Li K, Barankin B. Cutaneous manifestations of modern technology use. *J Cutan Med Surg*. 2011;15(6):347-353.
30. MZB Recalls Children's Watches Due to Risk of Skin Irritation; 2015. <https://www.cpsc.gov/Recalls/2015/MZB-Recalls-Childrens-Watches>. Accessed March 6, 2020.
31. McDonald's Recalls "Step-iT" Activity Wristbands Due to Risk of Skin Irritation or Burns; 2016. <https://www.cpsc.gov/Recalls/2016/mcdonalds-recalls-step-it-activity-wristbands>. Accessed March 6, 2020.

How to cite this article: Fenner J, Hadi A, Yeh L, Silverberg N. Hidden risks in toys: A systematic review of pediatric toy contact dermatitis. *Contact Dermatitis*. 2020;1–7. <https://doi.org/10.1111/cod.13500>