Original Article

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A retrospective review of skin prick test results in children with atopic diseases

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Abstract

This is a retrospective review of all the skin prick tests that were performed on atopic children between January 1997 and December 2011 in a regional hospital. One thousand nine hundred and fifty-nine patients with 2,032 tests were performed. Twenty-nine patients were excluded because the positive control was negative. Out of the 2,003 tests that were analysed, 1,410 tests were positive to at least one aeroallergen, which gives a prevalence rate of sensitisation of 70.4%. The top five most common aeroallergens were house dust mite, cat, dog, cockroach and tree pollens. There was no statistical significant difference in the rate of sensitisation between the genders. A clear secular trend was seen in the rate of sensitisation suggestive of a progressive sensitisation to aeroallergen during childhood ($p<0.05$). The positive predictive value of house dust mite positive to at least one other aeroallergen positive was 41.6%. The negative predictive value of negative house dust mite result to all other aeroallergens negative was 92.5%. This latter value would suggest that we could be more cost effective, easier to perform and most important of all less frightening to children in performing skin prick test by testing against house dust mite only in predicting atopic status. Knowing the sensitised aeroallergen would also allow practice of allergen avoidance and allergen immunotherapy.

Keywords: Allergic diseases, Children, Skin prick test

Introduction

Past decades have seen a dramatic increase in the prevalence of atopic diseases in children including asthma, allergic rhinitis, allergic conjunctivitis and urticaria especially in the developed countries. There is as yet no single theory that can fully explain this phenomenon. Most of the atopic diseases are related to type 1 hypersensitivity reaction or immunoglobulin E (IgE) mediated allergic reaction to an allergen especially aeroallergen. It has been demonstrated that at least 50% of children with frequent wheezing[1] and 75% of children with allergic rhinitis[2] were sensitised to aeroallergens. These diseases carry significant morbidity to the patients as well as negative effects to the family or the carers. Many patients would require medications but knowing the nature of the aeroallergen may aid our management of the diseases by allergen avoidance. Diagnosis of atopy usually involves investigations like total eosinophil, total IgE or specific IgE. For specific IgE, it could be assessed by either radioallergosorbent test (RAST) or skin prick test (SPT). For SPT, results are immediately available and the cost is much lower than that of RAST. SPT has been routinely done in this department for the last 2 decades. The current study reviewed SPT results done in this department for patients with atopic diseases as well as the adverse events associated with SPT.

Methods

This is a retrospective review of all children aged between 0 and 18 years who presented to this department with atopic diseases including asthma, allergic rhinitis, allergic conjunctivitis, atopic eczema and recurrent urticaria who had skin prick test performed between January 1997 and December 2011 except year 2000 when the service was suspended for one year because of administrative reasons. Children with history of anaphylaxis, angioedema and dermatographism were excluded from having skin prick test. Written consent was obtained from their parents or guardians. And they were asked to avoid all antihistamines, cough linctuses, oral steroid or bronchodilator, herbal medicines and any

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other medication that could affect the result for at least one week prior to the test. They should not use any perfume containing soap on the day of testing and have no acute illness.

The test was performed using the technique as described in the Allergy Diagnostic Testing: An Updated Practice Parameter published by the American Academy of Allergy, Asthma and Immunology (AAAAI) and the American College of Allergy, Asthma and Immunology (ACAAI).[3] Histamine and glycerol saline were used as positive and negative control respectively. Each patient would be tested against the following aeroallergens but not to all. They were Dermatophagoides pteronyssinus (Dp), Dermatophagoides farinae (Df), cat dander, dog hair, cockroach, feather mixture (duck, goose, hen), weed mixture (Golden rod, Dandelion, Ox-eye daisy, Cockelbur), and grasses (Cocksfoot, Sweet vernal-grass, Rye-grass, Meadow grass, Timothy). Molds mixture (Alternaria, mixed Aspergillus, Cladosporium sphaerospermum, mixed Penicillium) from ALK Abello, Denmark was used until December 2008. This was substituted with Penicillium mix (Penicillium digitatum, Penicillium expansum, Penicillium notatum) and Aspergillus mix (Aspergillus fumigatus, Aspergillus nidulans, Aspergillus niger) from Stallergenes, France from January 2009. Tree mixture (Birch, Hazel, and Poplar) from ALK Abello was tested until December 1999 and was discontinued afterwards. .The volar surface of the forearm was chosen for the test. The skin was pricked gently after the allergens were placed onto the skin with a lancet. This latter device was changed to Stallerpoint (Stallergenes, France) from January 2010.

The results were read 15 minutes after the prick. Positive reaction was defined as a wheal diameter of at least 3 mm larger than the negative control providing that the positive control was also positive. If the wheal was not circular then the mean of the longest and its perpendicular longest diameters were used.

Patients were sent home about one hour after the test. They were warned that there might be a milder reaction 8 to 10 hours afterwards. And they should return to the hospital if the reaction was significant.

Statistics

Since not all children were tested against all aeroallergens, percentages of positive tests were presented. Statistical analysis was performed using SPSS v10.1 (SPSS, Chicago, Illinois, USA). Data were presented as means and SD. χ^2 test was used for categorical data. Linear regression was used to calculate the secular trend. A p-value of <0.05 was considered statistically significant.

Results

A total of 2,032 skin prick tests were done in 1,959 children during this period of time. Twenty-nine patients had positive control being negative and were excluded. Results of 2,003 tests from 1,933 patients were analysed. There were 809 (40.4%) males and 1,194 females (59.6%). Sixty patients had 2 tests and 5 had 3 tests performed. Out of the 2,003 tests, 1,410 had at least one positive result and 593 were negative to all tested aeroallergen (Figure 1). The prevalence rate of sensitisation to at least one aeroallergen was 70.4%. The 5 most common aeroallergens in our cohort were house dust mite, cat, dog, tree mixture and cockroach. Their demographic data (Table 1) and the distribution frequency of individual aeroallergen were presented in Figure 2. There was no statistical significant difference in the positivity result to each aeroallergen between boys and girls. 71.4% of boys and 69.7% of girls were sensitive to at least one aeroallergen and there was no statistical significance between the 2 groups. The 5 most common aeroallergens in our cohort were house dust mite, cat, dog, tree mixture and cockroach (Figures 3 & 4).

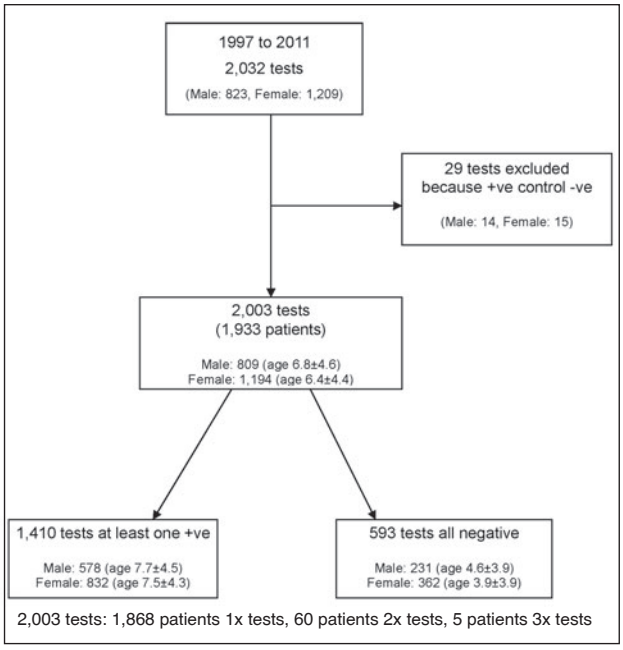

Figure 1. Flowchart for inclusion of skin prick test result for analysis from 1997 to 2011.

Table 1. Gender difference of the prevalence of sensitisation to individual aeroallergen

Gender	Total n=2,003	Male n=809 (40.4%)	Female n=1,194 (59.6%)	p value
Age	6.5±4.5	6.8±4.6	6.4±4.4	0.022*
Dp Df	61.9%	68.7%	67.5%	0.56
Cat	16.8%	16.9%	17.4%	0.78
Dog	14.3%	15.6%	7.8%	0.16
Tree mix	10.2%	12.7%	15.6%	0.07
Cockroach mix	8.9%	9.1%	8.8%	0.81
Mold mix	4.4%	5.0%	4.4%	0.52
Grass mix	5.4%	4.3%	6.2%	0.07
Feather mix	4.3%	3.7%	5.0%	0.29
Mixed asperigillus	2.7%	3.4%	1.6%	0.17
Mixed weeds	2.2%	2.3%	2.1%	0.83
Penicillium	0.8%	1.5%	0.5%	0.17
Mono	70.4%	71.4%	69.7%	0.40
Indoor mono (Dp, Df, cat, dog, cockroach, mold, asperigillus, penicillium)	69.6%	70.8%	68.8%	0.32
Outdoor mono (grass, feather, weeds, tree)	8.9%	8.0%	9.5%	0.24

Dp: Dermatophagoides pteronyssinus; Df: Dermatophagoides farinae

*Significant = p value <0.05

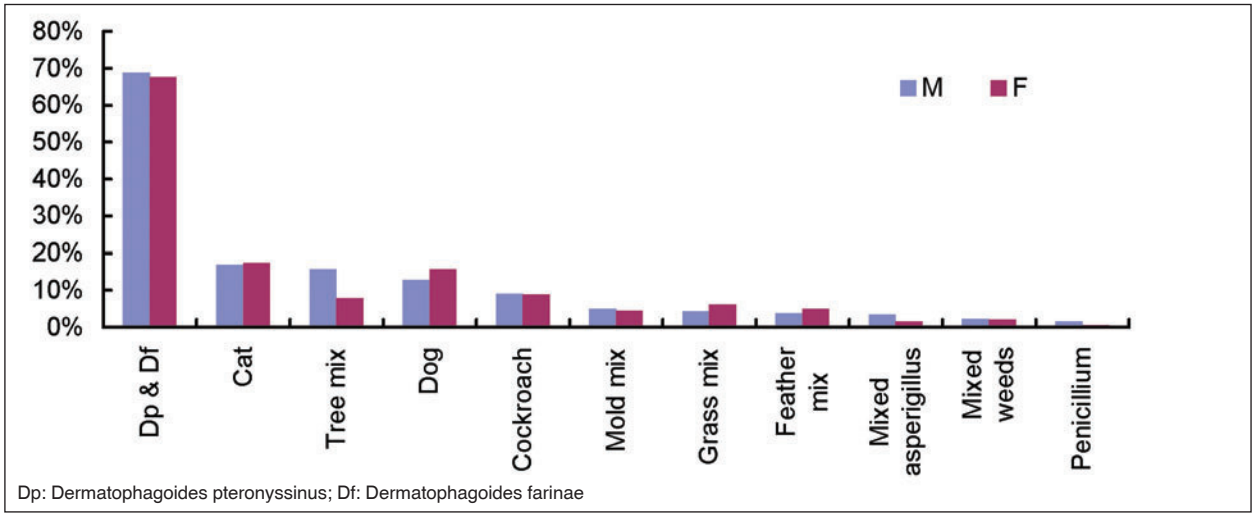

Figure 2. Distribution of the prevalence of sensitisation to individual aeroallergen.

Figure 3. The 5 most common aeroallergens in preschool children.

Indoor and outdoor aeroallergens

When we looked at the indoor aeroallergens (Dp, Df, cat, dog, cockroach, mold, aspergillus, penicillium), 70.8% of boys and 68.8% of girls were sensitive and there was no significant difference between the 2 groups. There was 8% of boys and 9.5% of girls sensitive to outdoor aeroallergens (grasses, feathers, weeds, trees) and again there was no gender difference in the positive rate (Table 1).

Secular trend of sensitisation

The secular trend of age against at least one allergen positive was shown in Figure 5. There was definitely a rising trend in the sensitisation rate which was statistically significant.

Sensitisation rate in different age groups

When we performed subgroup analysis between 0 to 5 years and six years or above, 55.2% of below 6 and 84.8% above 6 years old were sensitive to at least 1 aeroallergen. This was statistically significant (Table 2). There was also statistical significance between sensitisation rate to house dust mite, cat, dog, cockroach, grass mixture, mold mixture, feather mixtures, aspergillus mixture and penicillium.

Predictive value of house dust mite

Out of 2,003 tests, 1,362 (68%) were positive to house dust mite with 566 were positive to at least one other aeroallergen and 796 were negative to all other aeroallergens. The positive predictive value was 41.6%

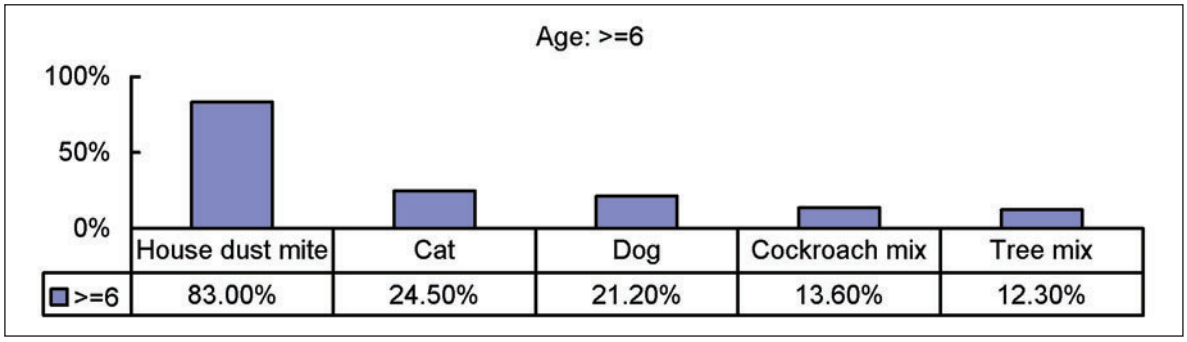

Figure 4. The 5 most common aeroallergens in school children.

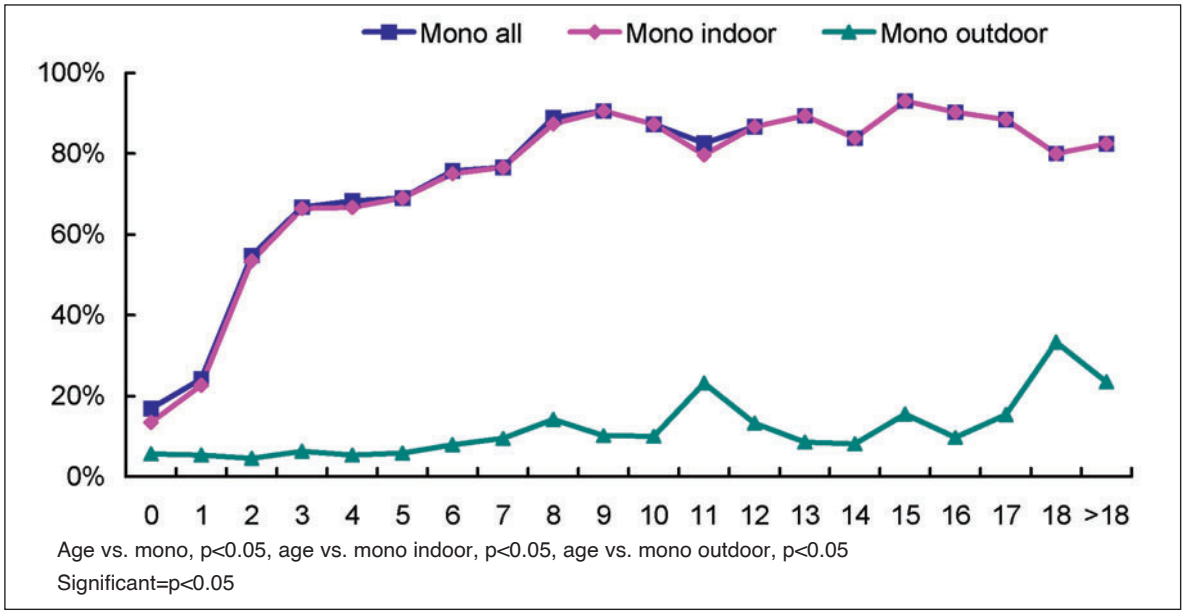

Figure 5. Secular trend of sensitisation to aeroallergens.

Table 2. Prevalence of individual aeroallergen sensitisation in pre-school and school children

Age group	0 to 5	>=6	p-value
Dp Df	52.3%	83.0%	<0.001*
Cat	9.6%	24.5%	<0.001*
Tree mix	8.9%	12.3%	0.508
Dog	7.4%	21.2%	<0.001*
Cockroach mix	3.7%	13.6%	<0.001*
Grass mix	2.8%	7.9%	<0.001*
Mold mix	2.7%	6.4%	<0.001*
Feather mix	2.7%	6.2%	0.003*
Mixed weeds	1.5%	2.8%	0.070
Mixed asperigillus	0.9%	4.5%	0.006*
Penicillium	0.0%	1.8%	0.012*
Mono	55.2%	84.8%	<0.001*
Indoor mono (Dp, Df, cat, dog, cockroach, mold, asperigillus, penicillium)	54.1%	84.3%	<0.001*
Outdoor mono (grass, feather, weeds, tree)	5.5%	12.2%	<0.001*

Dp: Dermatophagoides pteronyssinus; Df: Dermatophagoides farinae

*Significant = p<0.05

when house dust mite was positive. Of the 641 out of the 2,003 tests that were negative to house dust mite, 48 were positive to at least one other aeroallergen and 593 were negative to all other aeroallergens. This gave a negative predictive value of 92.5% to all aeroallergens if house dust mite was negative in our cohort (Figure 6).

Adverse event

There was no adverse event recorded during this period of review.

Discussion

There are 3 types of skin tests for allergic diseases, the prick test, the intradermal test and the patch test. The most commonly employed is the skin prick test. This involves placing a small drop of a solution containing a possible allergen on the skin followed by a prick using needle to allow the allergen to enter the skin. A wheal will develop if the person is allergic to that allergen. The intradermal test is more sensitive than the skin prick test but often gives false positive results. Finally the atopy patch test is used to detect T cell related skin allergy for example seen in contact dermatitis.

When properly performed skin prick test is safe. However severe anaphylactic reaction has been documented. Thus it is important to have resuscitation facilities available in case of emergency and the medical personnel must be fluent in resuscitating a patient with anaphylaxis.

Specific serum IgE can be measured using RAST. It is true that performing RAST is easier and less frightening especially to a young patient. It also does not carry the risk of anaphylaxis. However skin prick test can be an office based procedure. It will give faster results and is cheaper. More importantly both the patient and the parents can visualise the results thus reinforcing the message. It has been demonstrated that skin prick test is useful even in children as young as 3 months of age.[4]

Our cohort had more girls than boys, which was statistically significant (p=0.022). We have no reason for this disparity

The prevalence of aeroallergen sensitisation in our cohort was 70.4%, which is comparable to other hospital based studies.[5-7] However comparing to population based studies,[8,9] our prevalence rate is higher. In USA the NHANES III showed 54.3% of the cohort positive to at least one aeroallergen.[8] And in the Arshad study of the population cohort in Isle of Wright, only 19.2% of the subjects were positive to at least one inhalant allergen.[9] It has to be mentioned that in this latter study skin prick test was only performed in 4 years old children which was different from our study which included 0 to 18 years

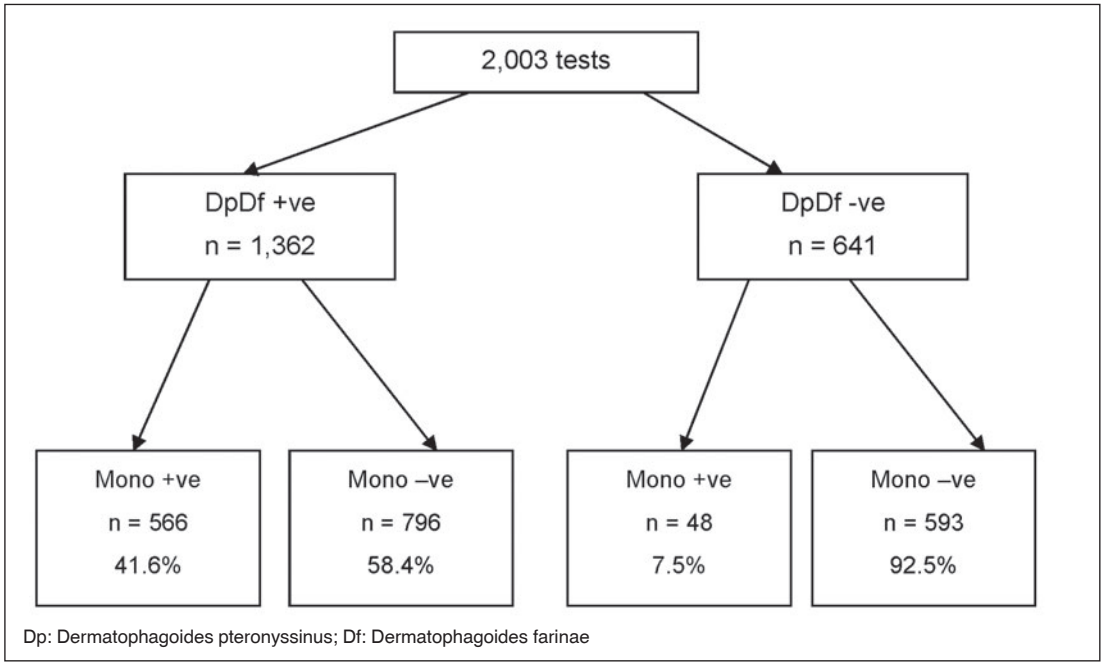

Figure 6. Predictive value of house dust mite.

old. The most likely reason for our rate being higher than these 2 population studies is due to the fact that we perform skin prick test on patients referred with atopic diseases.

The sensitisation rate to the three tree pollens (Birch, Hazel and Poplar) was 12.7 and 15.6% in boys and girls respectively which was more prevalent than cockroach and mold in our cohort. Hong Kong being an inner city with a humid environment, one would expect that cockroach and mold sensitisation rate would be higher then trees. This might be explained by the improvement in the hygiene and the use of air-conditioning. Unfortunately we did not continue with tree pollens after 1999 as it would be interesting to see whether there was a secular trend in the prevalence rate of tree sensitisation over the years.

School children usually spend more time outdoor thus we should expect a higher prevalence of outdoor aeroallergens than indoor aeroallergens in this age group comparing to preschool children. However when we analysed the prevalence of different aeroallergen in school children, we found that the indoor aeroallergen sensitisation was still higher. This might be explained by the fact that the hot weather makes children to stay indoor more than their counterparts in other parts of the world.

Allergen avoidance has been proposed to be part of the management programme in atopic diseases. By performing skin prick test, one can reinforce the message to parents and patients the measures to reduce exposure to sensitised aeroallergens. A review paper published by Custovic in 2006 suggested that allergen avoidance was beneficial in childhood asthma with sustained improvement but not in allergic rhinitis or eczema.[10]

Immunotherapy has been practised for nearly a hundred year. However this had not attracted popularity in the past especially in children as it involved a regular subcutaneous injection for a few years. Recently with the introduction of sublingual immunotherapy, this treatment is becoming more acceptable to children. A few meta-analyses have been published which demonstrated that the treatment was effective in various atopic diseases.[11-14] The authors had personal experiences with this treatment on few patients. An improvement in clinical symptoms had been demonstrated in at least 2 patients after one year on treatment. Unfortunately all patients decided to stop the treatment after one year due to financial reason thus no conclusion could be drawn.

The negative predictive value of a negative house dust mite result is 92.5% in our study. This suggests that we

can perform house dust mite first before deciding whether to proceed with other aeroallergens. This is especially useful clinically as we may not need to subject the child to many needle pricking. This would make skin prick test less traumatic and frightening to children. Also it will make the test a more cost efficient exercise.

Our study is limited by being a retrospective review. Not all children were tested against all aeroallergens especially tree pollens. And it would be beneficial if we could obtain more information on clinical symptoms to see whether there was any correlation between the age of sensitisation and development of clinical symptoms.

Conclusion

In conclusion, skin prick test is a safe procedure and complication is rare in experienced hand. The most common aeroallergens are house dust mite, cat, dog, tree pollens and cockroach. Knowing the sensitised aeroallergen could allow instigating measures for allergen avoidance and use of allergen immunotherapy. The latter treatment is gaining popularity in many parts of the world with the introduction of sublingual route of administration. In confirming atopy status, our study has shown that the negative predictive value of a negative house dust mite result is high suggesting that it is feasible to determine atopy status by determining the house dust mite result only. And only if we are contemplating immunotherapy or allergen avoidance should we test other aeroallergens are tested. This approach will make skin prick less traumatic to children and more cost effective.

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