Patch test results to baseline series: 20-year retrospective data from a tertiary care center in Thailand

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Abstract

Continuous surveillance of contact allergens is crucial for detecting emerging allergens, outdated substances, and shifts in sensitization rates influenced by environmental changes. This study aims to evaluate the prevalence and temporal trends of positive patch test responses to baseline series within the test population and to determine the most common allergens over a twenty-year period. A retrospective review was conducted on patch test data from the baseline series performed at the Institute of Dermatology, Bangkok, covering the period from 2002 to 2021. The prevalence rates of contact sensitization to each allergen were analyzed individually. Over the 20-year period, 10,812 patients underwent patch testing. Among these individuals, 65.4% exhibited at least one positive reaction. The five most common allergens with the highest positivity rates were nickel sulfate (26.7%), methylisothiazolinone (15.9%), fragrance mix I (12.3%), methylchloroisothiazolinone/methylisothiazolinone (10.6%), and cobalt chloride (8.0%). Colophonium and formaldehyde have demonstrated an increasing prevalence over time. Nickel continues to be regarded as the most commonly tested sensitizer in Asia. The presence of less common but clinically relevant allergens highlights the effectiveness of the baseline series, while the high patch test positivity rates observed for certain allergens underscore the importance of implementing appropriate legislation and regulatory measures.

Keywords: *patch test, contact allergy, allergic contact dermatitis, baseline series*

1. Introduction

Allergic contact dermatitis (ACD) is a delayed-type hypersensitivity reaction that occurs after the skin is exposed to a sensitizing allergen (McFadden et al., 2020). Continuous monitoring of sensitization rates is essential (Schnuch et al., 2012). At the Department of Community Medicine, Naresuan University in Phitsanulok, over the five years between 2015 to 2019, the most common condition affecting the skin and subcutaneous tissues was infection (37.3%), followed by dermatitis (29.7%), urticaria, erythema, other various skin and subcutaneous tissue disorders (8.6%), and papulosquamous disorders (1.7%). Dermatitis remains the second most prevalent skin condition (Sukakul et al., 2019a).

Patch testing is an essential diagnostic procedure for determining ACD. A group of commonly found allergens, known as the baseline, screening, or standard series, is used to carry out this test on the patient. The distribution of allergens can vary across countries and may shift over time. To address regional differences in sensitizing agents, various baseline series have been developed internationally (Dear et al., 2021). The North American Contact Dermatitis Group (NACDG) has agreed upon a standard list of 70 allergens. The European baseline series comprises 26 allergens, and the International baseline series has 32 (Sukakul et al., 2019a). The Bangkok Institute of Dermatology utilized a baseline series of 22 allergens from the beginning of the study until 2015. Since then, it has been replaced with the International baseline series of 32 allergens. Additional allergens from special series and/or patients' products were tested based on exposure history.

According to Fregret, *Bruze et al*. (Bruze et al., 1999), including any allergen in the standard series should be considered if more than 0.5-1% of tested patients show positive reactions (Boonchai & Kasemsarn, 2013). Monitoring the standard series has been found to facilitate the assessment of changes in allergy patterns, leading to adjustments for each population accordingly. This helps to manage and prevent ACD. In response to changes in the prevalence of contact allergies and variability in patch test sensitivities among populations, the North American Contact Dermatitis Group has revised the list of allergens used for baseline

testing almost annually (Wentworth et al., 2014). However, in Asia, fewer studies have examined the prevalence and sensitization rates based on patch testing compared to Western countries (Sukakul et al., 2019).

Therefore, it is imperative to conduct more studies in Thailand to determine the prevalence of allergens and the sensitization rate. Currently, no national consensus has been established regarding a standard patch test series in Thailand. Instead, the European Baseline (EBS) or the International Standard Series (ISS) is followed (Boonchai & Kasemsarn, 2013).

This study aimed to gather data on patch testing results from the baseline series from a tertiary care center in Thailand over two decades. It seeks to provide information on the prevalence of sensitization. The outcomes may inform future legislation and regulations to control allergic sensitization.

2. Objectives

1) To evaluate the prevalence and trends of positive patch test responses to baseline series among the patch test population
2) To identify the most frequently detected allergens over twenty years.

3. Materials and Methods

This study retrospectively reviewed the patch testing results of patients who were patch tested at the Bangkok Institute of Dermatology from January 1, 2002, to December 31, 2021. The registry received approval from the Ethics Committee of the Bangkok Institute of Dermatology (IRB/IEC 008/2566). Its operations were conducted in full compliance with the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines, and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP).

The patch testing was conducted in accordance with the guidelines of the International Contact Dermatitis Research Group (ICDRG) using Finn Chambers (SmartPractice, Phoenix, Arizona). The patches were applied to unaffected skin on the back for 48 hours, and the results were interpreted according to the ICDRG criteria (Lachapelle, 1997).

The data, including age, sex, the year of patch testing, the positive rates of patch test reactions, and final diagnoses, were collected using a case record form. The final diagnosis could be allergic contact dermatitis (ACD), irritant contact dermatitis (ICD), atopic dermatitis (AD), or a combination thereof. The data obtained represent patch testing outcomes using baseline series among the patch test population at a tertiary care center in Thailand. Since the number of patients tested for each allergen is varied, the prevalence of positive patch test reactions to each contact allergen was analyzed individually.

Datasets were analyzed using PASW for Windows, version 18.0 (SPSS Inc.). The results are presented in two categories: (1) Descriptive statistics—frequency, percentage, mean, median, mode, and standard deviation (SD), and (2) Inferential statistics: a chi-square test was employed to assess significant differences between male and female groups. Logistic regression was conducted to identify factors influencing patch test results, using a 95% confidence level over the last 20-year study period. A *p*-value of less than 0.05 was considered statistically significant.

4. Results and Discussion

4.1 Results

Between 2002 and 2021, a total of 10,812 patients were patch tested. Of these, 8,240 (76.2%) were females and 2,572 (23.8%) were males. Female patients had an average age of 39.5 years, while male patients had an average age of 43.8 years. A total of 7,067 patients (65.4%) exhibited at least one positive reaction to patch testing. The most common final diagnoses among the tested population were ACD, ICD, and AD. Details of the demographic data are presented in Table 1.

Nickel sulfate was the most commonly detected allergen, with a positive reaction rate of 26.7%, followed by methylisothiazolinone (MI), fragrance mix I, methylchloroisothiazolinone/methylisothiazolinone (MCI/MI), cobalt chloride, *Myroxylon pereirae resin*, fragrance mix II, colophonium, *para*-phenylenediamine, and potassium dichromate (Table 2).

From 2002 to 2017, there was a significant increase in the number of individuals who tested positive for allergic reactions to the preservative MCI/MI. The percentage of positive reactions to MCI/MI was notably high, reaching up to 24.6% in 2016. MI has become a common cause of contact allergy since the International Standard Series (ISS) was introduced in 2015. MI reached its highest prevalence in 2016 (30.8%). However, both MCI/MI and MI showed a decline in prevalence after 2017. Favorable response rates to *para*-phenylenediamine stayed between 8.3% and 9.5%, with no discernible change. Conversely, the prevalence rates of positive patch test results for formaldehyde and colophonium increased steadily throughout the study period.

According to recent patch testing data, specific contact allergens in the baseline series, such as budesonide, lanolin alcohol, imidazolidinyl urea, methyldibromo glutaronitrile, quaternium-15, diazolidinyl urea, and hydroxyisohexyl 3-cyclohexene carboxaldehyde (HICC), have shown relatively consistent positive reactions. However, most allergens like fragrance mix I and II, cobalt, neomycin, thiuram, mercaptobenzothiazole, N-Isopropyl-N-phenyl-4-phenylenediamine (IPPD), mercapto mix, paraben mix, and toluenesulfonamide formaldehyde resin have shown a significant decrease in positive responses in our cohort. Table 3 details the prevalence of the positive patch test reactions during the study period.

The prevalence of benzocaine, black rubber mix, and ethylenediamine did not significantly change from 2002 to 2015 as part of the baseline series in IOD. However, they have been excluded from our baseline series since 2015, and no further data can be evaluated.

Our study reveals that skin sensitization to haptens varies by age. In children under 18, the primary allergens are nickel, cobalt, and colophonium. For adults under 55, common allergens include nickel, fragrance mix I, and methylchloroisothiazolinone/methylisothiazolinone. In adults over 55, the primary allergens shift to fragrance mix I, nickel, and *Myroxylon pereirae resin*, with men showing the highest sensitivity to fragrance mix I. Furthermore, contact dermatitis in the elderly is more strongly linked to fragrances and preservatives than in younger age groups (Uter et al., 2002).

Table 1 General Demographic Data

Demographic data	Subject (n = 10812)	
	Number	**Percentage**
Gender		
Female	8240	76.2
Male	2572	23.8
Age (year)		
Median	39	
Mean	40.54	
Standard deviation	14.346	
Minimum	2	
Maximum	94	
Range	92	
Interquartile range	20	
95% Confidence Interval for Mean		
Lower bound	40.27	
Upper bound	40.81	
At least one positive result in the patch testing	7067	65.4
Final Diagnosis		
ACD	5717	80.9
ICD	689	9.7
AD	107	1.5
Other diagnoses	1636	23.2

4.2 Discussion

The surveillance data from the Institute of Dermatology were analyzed to observe and evaluate the changing patterns in contact allergy. The content of the baseline series varies over time and across different geographic locations, making direct comparisons between studies challenging. The changing patterns of the common allergens affecting our cohort are depicted in Figure 1. Based on the findings of this study, the baseline series currently being used in Thailand must be updated to better align with current exposures. For an extended period, nickel has been widely recognized as the most common sensitizer among patients who underwent patch testing worldwide. Interestingly, the most prevalent allergen in our study was also nickel sulfate. According to a study conducted in Taiwan from 1978 to 2018, 55.1% of patients experienced at least one positive allergic reaction (Lin et al., 2021).

Wearing jewelry, buttons, belt buckles, and eyeglass frames are typical sites of contact with nickel-containing objects. Ear piercing increases the risk of nickel sensitization. The percentage of nickel positivity in this cohort, 26.7%, was comparable to the rate in Japan which was 24% (Ito et al., 2022). Our result was much higher than that of other countries (DeKoven et al., 2021; Uter et al., 2021). However, a notable decline in the prevalence of nickel contact allergy was observed after 2013 (Figure 2). This could be explained by the availability of nickel-free alternatives, including rhodium or platinum, which are now used in jewelry instead of nickel (Sukakul et al., 2019a).

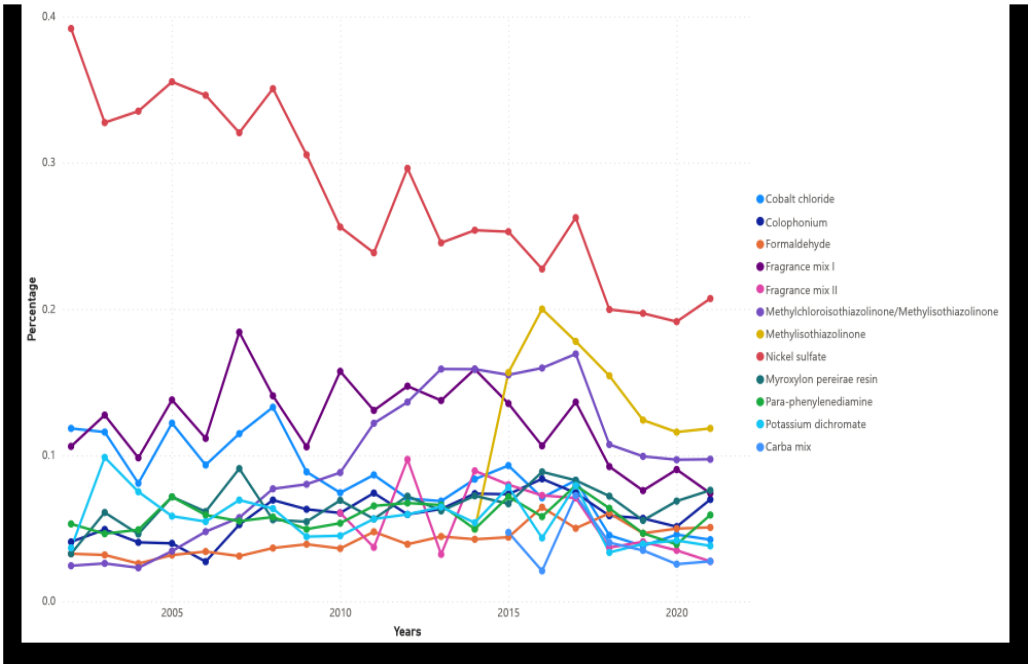

Figure 1 Changing trends of common contact allergens

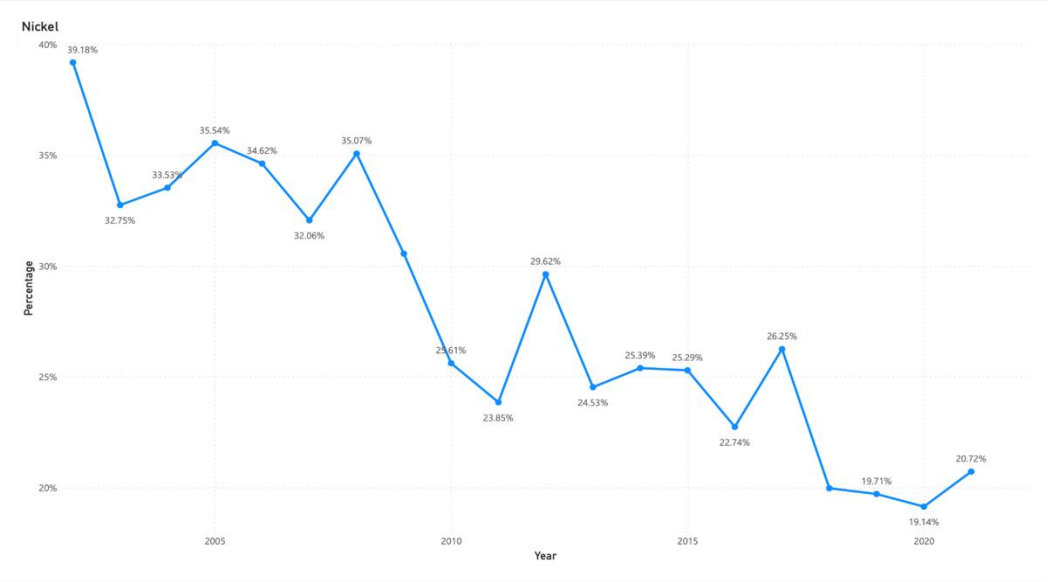

Figure 2 Changing trend of nickel allergen

Isothiazolinones, such as MCI/MI and MI, have been used as a preservative alternative since the ban of methyldibromoglutaronitrile in European cosmetics in 2008 (Lin et al., 2021). In Thailand, both domestic and foreign manufacturers supply skincare products, hair care products, and body cleansers. The preservatives most frequently found in these products are parabens, MCI/MI, and MI (Bunyavaree et al., 2016). Over the past 15 years, the use of MCI/MI in popular cosmetic products has been associated with a significant rise in isothiazolinone allergy cases in Thailand, which plateaued from 2013 to 2017 (Figure 3). Patch testing with MCI/MI may miss isothiazolinone allergy cases due to the low concentration of MI in the MCI/MI combination.

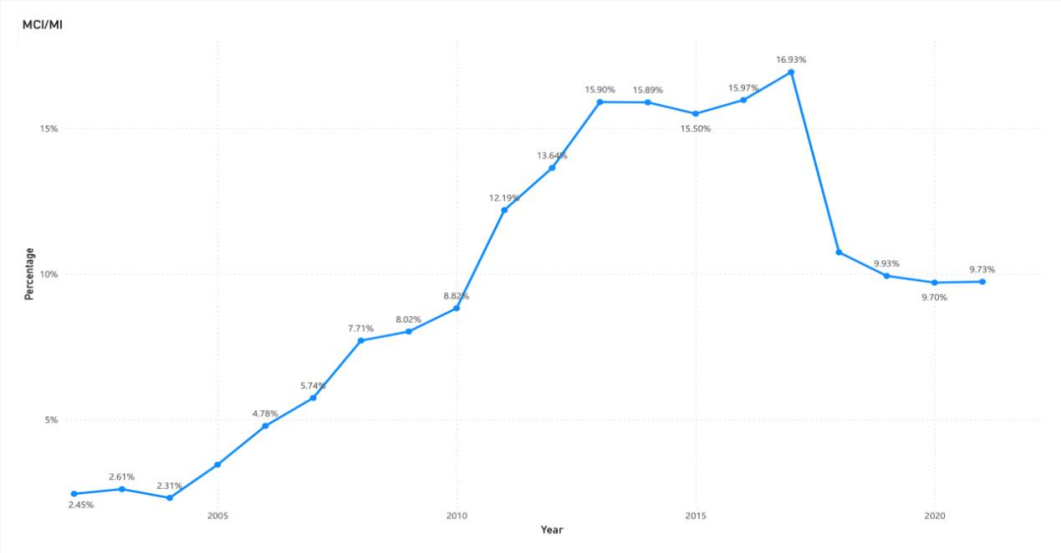

Figure 3 Changing trend of preservative allergen (MCI/MI)

An ICDRG multicenter study found that 32.7% of patients with MI contact allergy had not experienced any MCI/MI reactions (Isaksson et al., 2017). Consistent with the previously reported prevalence rates, our results show that 31.8% of individuals (215 out of 677) only responded positively to MI. However, it is noteworthy that the incidence of contact allergy has decreased for both MCI/MI and MI (Figure 4). This decrease may be attributed to the introduction of local laws prohibiting the use of MCI/MI and MI in leave-on cosmetic products while allowing very low concentrations in rinse-off products. These regulations were implemented in 2016 by the Thai FDA and the ASEAN Harmonised Cosmetic Regulatory Scheme (Thailand Information Center, 2012; Sukakul et al., 2019b). Although parabens are still an important allergen, the positivity rate was relatively low at 1.7%. We observed no significant changes in the prevalence of paraben allergy throughout the study period.

Fragrances are commonly encountered daily in cosmetics, perfumes, essential oils, household items, hygiene products, and food and beverages (de Groot, 2020). However, the prevalence of positive reactions to fragrance mix I and fragrance mix II has shown a decline (Figures 5 and 6), which aligns with the results reported by NACDG. This downward trend may be attributed to regulatory measures that imposed concentration limits on specific fragrance constituents in cosmetic products. Moreover, the reduced sensitization rates could stem from the increased availability of various alternative fragrance compounds that are not subject to mandatory labeling requirements when used in cosmetic formulations (Goossens, 2018; Silvestre et al., 2019).

Cobalt chloride, often found as a contaminant alongside nickel, is commonly used as an alloying agent to enhance the strength and durability of steel in various industrial and consumer applications. Trends in cobalt allergy have shown fluctuations over time—initially increasing, followed by a gradual decline. According to Thyssen et al. (2010), the substitution of nickel with cobalt in low-cost jewelry is likely to increase the frequency of cobalt allergy (Thyssen et al., 2010). In Thailand, Boonchai's research identified jewelry as the primary source of clinically relevant cobalt allergy. Their study discovered that 37.4% of jewelry products examined in the Thai marketplaces tested positive for cobalt (Boonchai et al., 2015). Furthermore, the widespread adoption of spot testing to detect cobalt in non-metallic objects may have contributed to reduced sensitization rates by encouraging avoidance of cobalt exposure (Fowler, 2016).

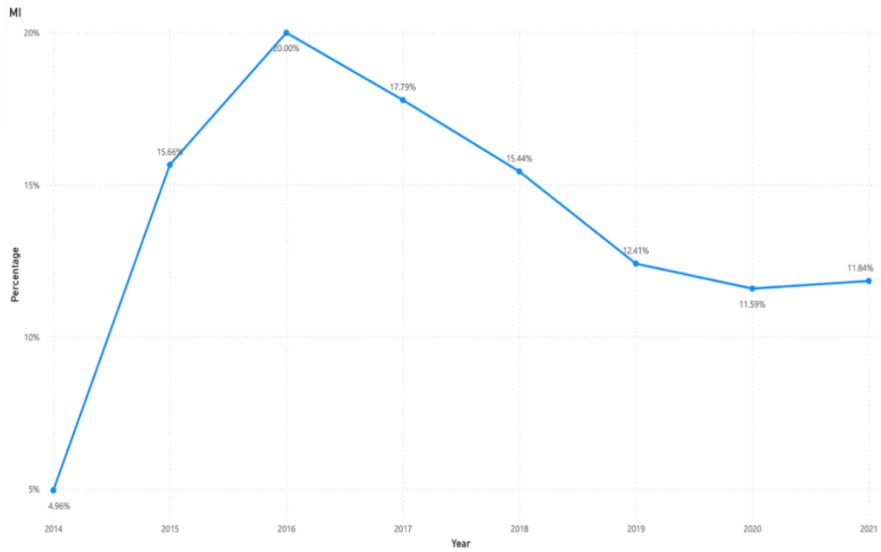

Figure 4 Changing trend of preservative allergen (MI)

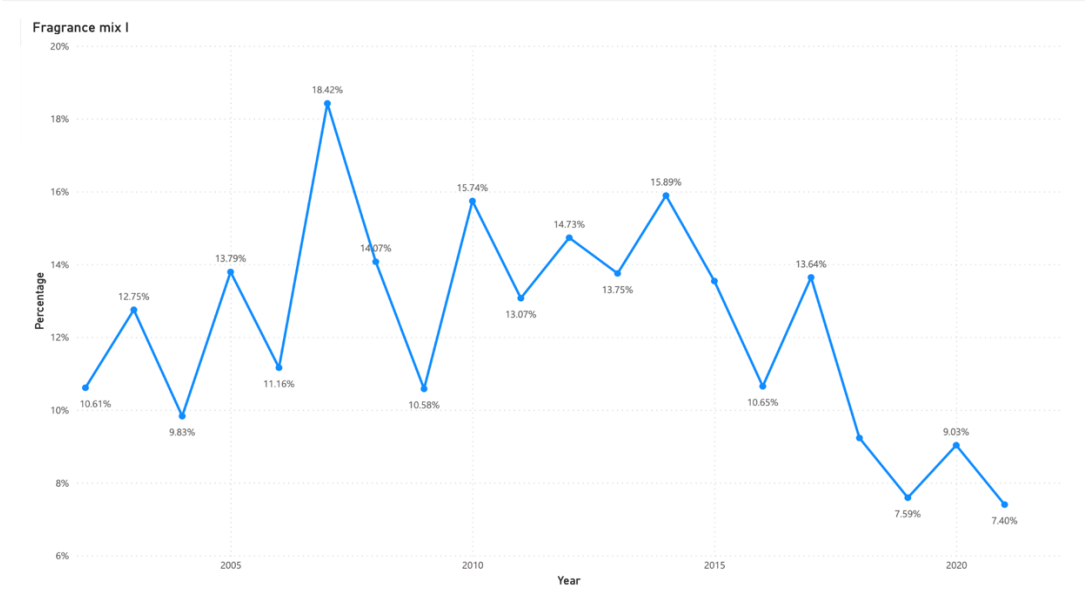

Figure 5 Changing trend of fragrance mix I

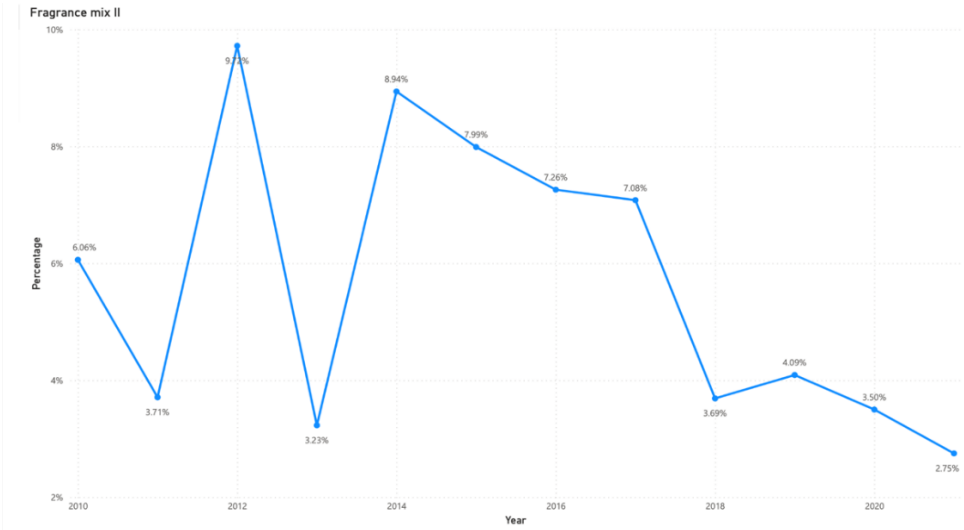

Figure 6 Changing trend of fragrance mix II

Myroxylon pereirae resin, also known as Balsam of Peru, is a natural fragrance mixture commonly used in cosmetics, perfumes, dental hygiene products, topical medications, and food flavorings. The prevalence of sensitization to *Myroxylon pereirae* resin has remained relatively stable over time. A study conducted in Spain reported that sensitization to this resin and its clinical relevance are notably common in adults (Pesqué et al., 2025). This may contribute to the consistent prevalence observed in our study, given that the average age of patients undergoing patch testing is 40.54 years. Another possible explanation is the widespread use of traditional Thai balms, which may contain herbal compounds that chemically resemble those found in Asian cuisine and regional cosmetic formulations. Additionally, many synthetic and natural fragrances contain chemical constituents similar to those in the resin, which could lead to cross-reactivity and persistent sensitization.

Colophonium, an organic resin naturally derived from pine trees, is the basis for numerous glues and adhesives. It is commonly found in products such as varnishes, plasticizers, adhesives, textiles, finishers, cosmetics, and waxes (McFadden et al., 2020). Notably, the incidence of sensitization to colophonium, one of the top ten allergens in our baseline series, has increased throughout the study period. A retrospective investigation in Thailand regarding footwear-related ACD revealed that 7.7% of all allergens identified were adhesive allergens. Among these, colophonium emerged as the most common adhesive allergen (Chaiyabutr et al., 2024). The authors' perspective highlights a significant concern that warrants attention.

Hair coloring is the primary source of *para*-phenylenediamine (PPD) in the modern era. Exposure to oxidative hair dyes is typically associated with contact allergy to PPD (Schnuch et al., 2008). Our study indicates that the rate of PPD sensitization has remained stable, with 5.8% of patients with dermatitis identified as allergic to PPD. This consistent trend may be attributed to a shift in societal perceptions of beauty and fashion, resulting in an increasing number of individuals opting for hair coloring. In Thailand, regardless of gender identity, many individuals regularly dye their hair using oxidative hair dyes to alter its natural black color on a monthly basis. Furthermore, PPD remains prevalent in the majority of Thai hair dyes, and cross-reactions with TDS (toluene-2,5-diamine sulfate) are still possible.

Chromium is the most significant occupational allergen in Thailand, particularly affecting construction workers. It is commonly present in materials such as cement, chromium plating processes, rust-resistant paints, tattoos (specifically green), and certain types of leather. Historically, cement was a common source of exposure to both cobalt and chromium. A key sensitizing component in cement that can lead to allergic contact dermatitis is hexavalent chromium (Cr(VI)). The implementation of regulated Cr(VI) levels in cement worldwide could potentially alter the situation concerning ACD (Lejding et al., 2023). Several cement manufacturers in Thailand have declared the reduction of Cr(VI) use. However, a sample of cement from one Thai manufacturer still showed elevated Cr(VI) levels in an EU analysis (Lejding et al., 2023). In addition, a recent study from Sweden has identified additional chromium exposure sources, including tanned leather and metallic dyes (Lejding et al., 2018). All of these factors have contributed to the absence of any significant changes in the positive responses to chromium in the current study.

Epoxy resin is a significant occupational allergen. Its characteristics, such as ease of curing, low shrinkage, excellent adhesiveness, high physical strength, and resistance, as well as superior electrical resistance, make it highly suitable for a wide range of commercial applications. The rate of positive responses remained consistent in our cohort. This indicates that workplace hygiene, especially in environments such as spray painting, construction sites, and pipe relining, requires improvement (Brans et al., 2019).

Throughout the study, we observed a gradual increase in formaldehyde-positive patch test reactions, which may be attributed to its presence in consumer products that are not listed on the label (Hauksson et al., 2016). Nevertheless, the incidence of allergies caused by formaldehyde releasers, such as quaternium-15, imidazolidinyl urea, and diazolidinyl urea, remained largely unchanged since the introduction of the ISS. Notably, these preservatives were present in only a small proportion of consumer products in the Thai market (Bunyavaree et al., 2016).

Rubber and its accelerators have long been recognized as strong contact allergens (Warburton et al., 2017). According to the study, the sensitivity to nearly all rubber allergens in the baseline series has significantly decreased. Among the allergens in the rubber group, Carba mix exhibited the highest proportion of positive patch test reactions at 3.9%, followed by thiuram mix, mercaptobenzothiazole, mercapto mix, and N-Isopropyl-N-phenyl-4-phenylenediamine (IPPD). IPPD demonstrated the lowest positivity rate at 0.7%. This compound is a rubber antioxidant typically found in black or dark grey rubber. The observed decline in rubber allergy is likely due to the substitution of rubber with alternative materials, such as silicone, acrylonitrile, butadiene, or polyvinyl chloride, as well as the implementation of enhanced primary preventive strategies in occupational settings.

Neomycin, an aminoglycoside antibiotic, is widely used in topical formulations such as creams, ointments, and eyedrops. It is frequently combined with other antibacterial medications and corticosteroids, which can result in contact sensitization. The widespread availability of neomycin-containing over-the-counter products has contributed to a notably high sensitization rate of 3.3% in Thailand. However, with

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increased clinical awareness regarding neomycin-induced contact dermatitis, our current study observed a decline in neomycin sensitization rates. The prevalence of neomycin allergy varied geographically: in North America, it ranged between 10% and 13%, whereas in ten European nations, the sensitivity was only 1.9%. Due to reduced utilization in specific regions, the German Contact Dermatitis Research Group removed neomycin sulfate from the baseline series several years ago (Uter et al., 2021). Regarding corticosteroid allergens, no significant change in sensitization trends was found for budesonide and tixocortal-21-pivalate.

Table 2 List of the allergens according to their positivity rate over 20 years

No	Allergens	Number	Patch test positive reaction (%)
1	Nickel sulfate	2881	26.7
2	Methylisothiazolinone	677	15.9
3	Fragrance mix I	1327	12.3
4	Methylchloroisothiazolinone/Methylisothiazolinone	1147	10.6
5	Cobalt chloride	856	8.0
6	*Myroxylon pereirae resin*	725	6.8
7	Fragrance mix II	429	6.4
8	Colophonium	662	6.1
9	*para*-phenylenediamine	629	5.8
10	Potassium dichromate	602	5.6
11	Formaldehyde	471	4.4
12	Carba mix	164	3.9
13	Hydroxyisohexyl 3-cyclohexene carboxaldehyde	158	3.5
14	Neomycin sulfate	357	3.3
15	Thiuram mix	356	3.3
16	Methyldibromoglutaronitrile	91	1.9
17	Mercaptobenzothiazole	198	1.8
18	Paraben mix	183	1.7
19	Lanolin	150	1.4
20	Quaternium-15	140	1.3
21	Benzocaine	86	1.3
22	4-tert-Butylphenol	131	1.2
23	Mercapto mix	127	1.2
24	Compositae mix	41	0.9
25	Black rubber mix	58	0.9
26	Imidazolidinyl urea	39	0.9
27	Diazolidinyl urea	38	0.9
28	Ethylenediamine	56	0.8
29	Sesquiterpene lactone mix	32	0.7
30	N-Isopropyl-N-phenyl-4-phenylenediamine	30	0.7
31	Epoxy resin	67	0.6
32	Toluenesulfonamide formaldehyde resin	23	0.5
33	Budesonide	22	0.5
34	Tixocortal-21-pivalate	19	0.4
35	Hydrocortisone-17-butyrate	6	0.1

Table 3 Patch test positive reaction between 2002-2021

Allergens	Total PT Positive (n=7067)		% PT Positive reaction - Years																			p-value
	n	%	2002 (n=156)	2003 (n225)	2004 (n=216)	2005 (n=861)	2006 (n=280)	2007 (n=277)	2008 (n=348)	2009 (n=379)	2010 (n=382)	2011 (n=360)	2012 (n=429)	2013 (n=487)	2014 (n=504)	2015 (n=420)	2016 (n=403)	2017 (n=414)	2018 (n=377)	2019 (n=404)	2020 (n=451)	2021 (n=294)	
Nickel sulfate	2881	26.7	61.5	50.2	53.7	51.3	54.3	48.4	52.3	47.2	38.7	37.5	44.1	37.4	35.5	36.9	34.9	36.7	31.6	33.4	31.5	33.3	<0.000*
Methylisothiazolinone (MI)	674	15.9													6.7	22.6	30.8	24.6	24.4	21.0	19.0	19.0	<0.000*
Fragrance mix I	1327	12.3	16.7	19.6	15.7	19.9	17.5	27.8	20.9	16.4	23.8	20.6	21.9	20.9	22.2	19.8	16.4	19.1	14.6	12.9	4.9	11.9	<0.000*
Methylchloroisothiazolinone/ Methylisothiazolinone (MCI/MI)	1146	10.6	3.8	4.0	3.7	4.9	7.5	8.6	11.5	12.4	13.3	19.2	20.3	24.2	22.2	22.6	24.6	23.4	16.9	16.8	15.9	15.6	<0.000*
Cobalt chloride	856	8.0	18.6	17.8	12.9	17.6	14.6	17.3	19.8	13.7	11.3	13.6	10.5	10.5	11.7	13.6	10.9	11.6	7.2	6.4	7.5	6.8	<0.000*
Myroxylon pereirae resin (BOP)	724	6.8	5.1	9.3	7.4	10.3	9.6	13.7	8.3	8.4	10.5	8.9	10.7	9.4	10.1	9.8	13.6	11.4	11.4	9.4	11.3	12.2	<0.000*
Fragrance mix II	429	6.4											14.5	4.9	12.5	11.7	11.2	9.9	5.8	6.9	5.8	4.4	<0.000*
Colophonium	662	6.1	6.4	7.6	6.5	5.7	4.3	7.9	10.3	9.8	9.2	11.7	8.9	9.7	10.3	10.7	12.9	10.4	9.3	9.7	8.4	11.2	<0.000*
para-Phenylenediamine (PPD)	628	5.8	8.3	7.1	7.9	10.3	9.3	8.3	8.6	7.7	8.1	10.3	10.0	10.1	6.9	10.2	8.9	11.1	10.1	7.9	6.4	9.5	0.004
Potassium dichromate	602	5.6	5.8	15.1	12.0	8.4	8.6	10.5	9.5	6.9	6.9	8.9	8.9	9.9	.5	11.4	6.7	11.1	5.3	6.7	6.9	6.1	0.002
Formaldehyde	471	4.4	5.1	4.9	4.2	4.6	5.4	4.7	5.5	6.1	5.5	7.5	5.8	6.8	5.9	6.4	9.9	7.0	9.5	7.9	8.2	8.2	0.003
Carba mix	163	3.9														6.9	3.2	9.9	6.4	5.9	4.2	4.4	<0.000*
Hydroxyisohexyl 3-Cyclohexene Carboxyldehyde (Lyral)	158	3.5											0.5	0.8	2.8	5.2	7.2	5.8	3.7	4.5	3.5	3.4	<0.000*
Neomycin sulfate	357	3.3	6.4	8.0	7.9	6.9	6.4	7.9	.2	4.7	4.9	4.4	4.7	4.3	4.8	6.4	4.5	4.6	3.2	3.2	3.5	2.0	<0.000*
Thiuram mix	356	3.3	7.0	8.0	6.0	6.1	4.6	4.7	3.2	4.2	5.2	5.5	3.3	4.3	5.2	5.0	6.5	5.8	5.3	4.7	4.9	4.1	0.073
Methyldibromoglutaronitrile	90	1.9											0.9	0.2	0.9	2.4	1.5	7.5	2.7	3.5	0.7	1.4	<0.000*
Mercaptobenzothiazole	198	1.8	8.3	8.0	2.8	6.9	2.5	2.9	2.6	2.9	3.9	2.8	3.0	3.3	2.2	0.7	1.5	1.9	1.3	1.9	2.7	0.3	<0.000*
Paraben mix	183	1.7	3.2	4.4	2.8	1.9	2.1	2.3	2.6	1.8	3.6	2.8	2.8	3.5	1.6	2.6	4.2	2.9	3.2	1.2	1.6	2.0	<0.000*
N-Isopropyl-N-phenyl-4-phenylenediamine (IPPD)	30	0.7													0.4	1.2	1.5	1.2	0.5	0.2	1.1	0.0	<0.000*
Mercapto mix	127	1.2	7.1	6.7	2.3	4.2	1.8	1.4	1.7	1.8	2.1	1.9	2.1	1.4	1.9	0.5	0.7	1.4	1.3	0.7	0.7	0.0	<0.000*
Epoxy resin	67	0.6	0.6	2.2	0.9	0.4	1.4	1.4	1.1	1.3	0.8	0.6	0.5	1.0	1.8	0.7	0.2	0.7	0.8	1.5	0.2	1.0	0.018
Quaternium-15	140	1.3	1.9	1.8	1.4	1.9	0.7	3.6	1.7	2.6	2.4	1.7	2.1	2.5	1.8	3.3	2.2	1.9	1.6	2.2	1.3	0.0	<0.000*
Imidazolidinyl urea	39	0.9											0.2		0.2	0.7	1.9	0.7	2.1	1.5	0.7	2.0	<0.000*
Diazolidinyl urea	38	0.9													0.4	0.2	1.5	1.2	2.7	1.7	0.7	1.4	<0.000*

5. Conclusion

Among the patch test population, 65% exhibited at least one positive reaction. Nickel remained the most common hapten, followed by methylisothiazolinone, fragrance mix I, MCI/MI, and cobalt chloride. An upward trend was observed for colophonium and formaldehyde. While uncommon allergens with clinical significance demonstrate the effectiveness of the baseline series, high-frequency allergens underscore the necessity for regulatory interventions.

Limitations:

- Not all allergens are tested annually.
- The clinical relevance was not assessed.

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