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The impact of skin prick testing on pain perception and anxiety in children and parents

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Abstract

Background: Skin prick testing (SPT) is a major diagnostic tool in patients with allergic symptoms. The testing process may involve pain, anxiety, and stress on children and parents.

Objective: We aimed to measure the level of pain and anxiety before and after SPT in children and parents, and tried to identify predictive factors.

Methods: The children underwent SPT and parents completed the State Trait Anxiety Inventory (STAI) S-Anxiety before and after SPT, T-Anxiety before SPT. The study nurse completed Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) scores (<5 years) or Wong-Baker FACES Pain Rating Scale (VAS), (≥5 years) after the SPT, in order to quantify pain.

Results: A total of 523 children (5.3 [2.8-9.1] [median, interquartile range] years old, 59.5% male) were evaluated. Parent gender was a predominant factor for anxiety, as mothers had a higher pre-test STAI (S-Anxiety) score, STAI (T-Anxiety), and post-test STAI (S-Anxiety) score than fathers ($p < 0.001$). Pre-test STAI (S-Anxiety) scores of parents decreased with increasing age (for 0-<5 years, 5-<12 years, and ≥12 years; [p for trend = 0.016]). The children tested on the back had higher VAS scores compared with the ones tested on the forearm [2[0-4] vs 2[0-2], [p = 0.005]]. Risk factors determining higher general anxiety STAI (T-Anxiety) scores above the median were female sex for the parent (OR = 1.68; 95% CI [1.10-2.57]; p = 0.017), and parent's education level being greater than or equal to high school level (OR = 1.83; 95% CI [1.27-2.64]; p = 0.001).

Conclusion: SPT may cause anxiety and pain in a subgroup of children particularly in younger age, and if performed on the back. Anxiety levels were higher in mothers, and in parents with high education levels.

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Introduction

Nearly all of the allergic evaluations include skin prick testing (SPT), and it is regarded as gold standard for diagnosing immunoglobulin (Ig) E-mediated allergic diseases.¹ Prick testing has many advantages when diagnosing atopic diseases, including easy application, minimal invasiveness, low cost, quick result, high sensitivity, and specificity.¹ Furthermore, it is a preferential instrument when selecting proper allergens for immunotherapy.²

SPT is usually applied easily without discomfort in adults, and most of the patients tolerate testing without any annoyance. But as a nature of the process, it may cause stress and anxiety in a subgroup of patients, especially in children. Similarly, needles using minimal invasive interventions like venipuncture,³ dental treatment,⁴ and routine immunizations⁵ can cause discomfort in children, and distraction methods were used to cope with the distress and pain.⁶

Even in adults, medical procedures especially in surgery can cause anxiety and pain, sometimes requiring music interventions to lessen them.⁷

There is limited knowledge about the effects of SPT on pain perception, and anxiety in childhood. Some applications were reported to alleviate and ameliorate pain during SPT using topical dermal anesthesia before SPT,^{8,9} local antihistamines,¹⁰ hypnosis,¹¹ and vapocoolant spray.¹² Also, various single-headed and multi-headed SPT devices,^{13,14} and different techniques of application were compared with each other for pain relief and tolerability.¹⁵ Furthermore, several distraction methods were used to relieve pain and anxiousness,¹⁶ such as melomics music¹⁷ and medical clowns,¹⁸ and found effective to lessen pain perception and anxiety.

We thus hypothesized that SPT might cause fear and discomfort in some group of children and their families. Therefore, in the present study, we would like to identify the effects of SPT on children's pain perception and parent's anxiety. Additionally, we tried to determine a number of risk factors which can affect pain and anxiety, both in children and their parents during SPT.

Methods

Study population

All consecutive children aged 2 months to 18 years, in whom SPT was ordered by an allergist, and their parents were invited to participate in the study after the explanation about the testing procedure during a period of 6 months between June 2014 and November 2014. The study was performed in the outpatient clinic of the pediatric allergy department of a tertiary referral center.

Pain memories can influence future pain experiences.¹⁹ Therefore, we excluded the children and their parents who had undergone painful medical procedures such as surgery, blood drawing, hospitalization, intramuscular injections, and dental treatments within 3 months, from the study period to circumvent contradictory, and biased results. And, also subjects which may have negative impact on the testing procedure such as any psychiatric

disease, dermatographism, and severe atopic dermatitis were excluded from the study. Antihistamines were withheld for 1 week, and children who received any pain medication within the last 24 hours or those who used antidepressant drugs were excluded from the study.

The study was approved by the local ethics committee of the Hacettepe University and informed consent was obtained from both patients and children if they were over 6 years of age (25.06.2014-GO 14/309-17).

Study design

The study questionnaire, concerning the age, gender, chronic disease, previous prick testing, number of previous prick testing for both children and parent, education of parent, testing site of the children, and the result of SPT were filled out for each participant.

Patients were subjected to SPT on their upper back or volar aspect of forearms with a single-headed skin prick test device (Stallerpoint® Antony, France) and tested with 12 ± 2 allergens and with histamine (10 mg/ml of histamine phosphate) as a positive control, and 0.9% sterile saline as a negative control,²⁰ thus, in total, 14 ± 2 pricks were performed. SPT was considered positive if the mean wheal diameter was ≥ 3 mm compared with the negative control.

All of the subjects under the age of 5 years underwent SPT on the upper back side and for those above 5 years of age, SPT was applied either on upper back or forearm considering the patients' preference and physical structure.

Skin prick testing

All of the skin tests were performed by the same experienced nurse, and evaluated by the same physician. The same experienced study nurse performed the test, depending on the age of the children, either on the back or volar aspect of forearms with a spacing of at least 20 mm between each test site. The nurse placed an allergen and applied vertical pressure, followed by a 90° clockwise rotation. Before the study, the study nurse underwent an evaluation and a 'coefficient of variation' (CV) of <20% was attained (8.9%).¹⁵

Pain quantification

The children ≥ 5 years of age were instructed to rate their pain after the implementation of SPT by using the Wong-Baker FACES Pain Rating Scale (VAS). This scale ranges from 0 to 10, where 0 indicates no pain and 10 represents the worst pain imaginable.²¹

For children younger than 5 years of age after SPT, the pain score was determined by using the CHEOPS (Children's Hospital of Eastern Ontario Pain Scale) by the same study nurse experienced in this issue. This scale ranges from 4 to 13, where 4 indicates no pain and 13 represents the worst pain imaginable.²²

Since, children's reactions to pain responses vary in different ages, we divided them into age groups to evaluate pain better.²³ Age groups of the patients were defined in

the whole group; as preschoolers (0-<5 years), school children (5-<12 years), and adolescents (12-18 years). Children under 5 years of age were also subdivided as infants (0-<1 year), toddlers (1-<3 years), and preschoolers (3-<5 years) age groups.²⁴

Anxiety quantification

The State-Trait Anxiety Inventory (STAI) was used to assess the parents' anxiety levels.²⁵ STAI is a questionnaire which is a psychological inventory based on a 4-point Likert Scale, and consists of 40 questions on a self-report basis. The STAI has 40 items, 20 items allocated to each of the State Anxiety Scale (S-Anxiety) and Trait Anxiety Scale (T-Anxiety) subscales. From these two subscales within this measure, the S-Anxiety evaluates the current state of anxiety, which is used to measure situational anxiety, before and after the skin testing procedure. The T-Anxiety evaluates relatively stable aspects of anxiety proneness as a personal characteristic reflecting general anxiety level and performed only before SPT. Higher scores were positively correlated with higher levels of anxiety.²⁵ Parents fulfilled S-Anxiety before, and 15 minutes after SPT, and T-Anxiety only before SPT.

Statistical analysis

The SPSS Statistics Version 22.0 (IBM, Chicago, IL, USA) was used for all calculations. Descriptive data for categorical variables were expressed as frequencies. The distributions of all numerical variables including the age of children and parents, VAS, and CHEOPS and STAI scores were skewed; thus, the results were summarized as medians and interquartile ranges [IQR]. Group comparisons were established using either Kruskal-Wallis test or Mann-Whitney U test for medians (and ranges) and the chi-square test for

categorical variables. Correlation analysis was performed by using Spearman Correlation analysis. For the risk factor analysis of STAI general anxiety scores, the scores were first dichotomized as above or below median values and then the risk analysis was performed using univariate and multivariate logistic regression analysis. P for trend analysis was performed by Jonckheere-Terpstra test.

Results

Characteristics of the study population

A total of 523 children (59.5% male), the median (IQR) age was 5.3 (2.8-9.1) years, and their accompanying parents, (median [IQR] age was 34.2 (30.1-39.3) years, 22.2% in fathers) were included in the study. The characteristics of the study population are summarized in Table 1.

Pain scores in children and risk factors that predict higher scores

CHEOPS scores differed significantly between age groups among preschool children (<5 years). When this age group was further subdivided into three groups according to their psychosocial developmental periods as 0-<1, 1-<3, and 3-5 years; the CHEOPS scores reached their highest between 1 and 3 years of age ($p = 0.024$; Table 2). The statistical difference was due to a low pain score of 0-<1 year-old children.

In children aged 1 to 3 years, CHEOPS were significantly higher when their mothers had a post-test STAI (S-Anxiety) score above the median level (8 [7-10.25] vs 7 [6-9], $p = 0.008$).

In addition, the risk of having a CHEOPS score above the median was higher in children if their parent had an educational level of high-school or more (OR = 1.84; 95% CI [1.07-3.15]; $p = 0.028$).

Table 1 Characteristics of the study population.

	Whole group N = 523	0-<5 years of age N = 246	5-<12 years of age N = 200	12/18 years of age N = 77
Children age (years) [†]	5.3 (2.8-9.1)			
Children M/F, n (%)	311/212 (59.5/40.5)	141/105 (57.3/42.7)	130/70 (65.0/35.0)	40/37 (51.9/48.1)
Having chronic disease, n (%)	106/417 (20.3)	25/221 (10.2)	57/143 (28.5)	24/53 (31.2)
Previous skin prick testing, n (%)	220/303 (42.1)	65/181 (26.4)	114/86 (57.0)	41/36 (53.2)
Parent age (years) [†]	34.2 (30.2-39.3)	31.4 (28.0-36.1)	35.0 (32.0-39.5)	41.9 (37.0-46.1)
Parent gender M/F	116/407 (22.2/77.8)	46/200 (18.7/81.3)	49/151 (24.5/75.5)	21/56 (27.3-72.7)
Previous prick testing of parent, n (%)	43/480 (8.2/91.8)	13/233 (5.3/94.7)	24/176 (12.0/88.0)	6/71 (7.8/92.2)
Parent education ≥ high school, n (%)	324/199 (62.0/38.0)	165/81 (67.1/32.9)	122/78 (61.0/39.0)	37/40 (48.1/51.9)
Parent general anxiety T-STAI [†]	43.0 (38.0-48.0)	43.0 (38.0-48.0)	42.0 (37.0-48.0)	44.0 (38.0-49.0)
Parent pre-test S-STAI [†]	40.0 (33.0-46.0)	41.0 (34.0-47.0)	40.0 (32.3-47.0)	38.0 (30.5-4.0)
Parent post-test S-STAI [†]	40.0 (33.0-46.0)	41.0 (34.0-46.0)	40.0 (32.0-45.0)	37.0 (29.5-46.0)
CHEOPS score [†]	7 (6-9)	7 (6-9)		
VAS (WONG-BAKER faces score) [†]	2.0 (0.0-2.0)		2.0 (0.0-2.0)	2.0 (0.0-2.0)
Prick Testing site forearm/back (%)	168/355 (32.1/67.9)	All from the back	92/108 (46.0/54.0)	73/4 (94.8/5.2)

[†]median (interquartile range).

Table 2 Characteristics of the children <5 years of age with subdivision of 0-<1, 1-<3 and 3-<5 years of age groups.

	0-<1 years of age N = 40	1-<3 years of age N = 100	3-<5 years of age N = 106
Children M/F, n (%)	21/19 (52.5/47.5)	60/40 (60.0/40.0)	60/46 (56.6/43.4)
Having chronic disease, n (%)	2/38 (5.0)	9/91 (9.0)	14/92 (13.2/86.8)
Previous skin prick testing, n (%)	6/34 (15.0)	26/74 (26.0)	33/73 (31.1)
Parent age (years) [†]	29.9 (26.6-33.0)	30.9 (27.2-35.9)	32.7 (29.9-37.3)
Parent gender M/F	4/36 (10.0/90.0)	18/82 (18.0/82.0)	24/82 (22.6/77.4)
Prick testing of family, n (%)	1/39 (2.5/97.5)	5/95 (5.0/95.0)	7/99 (6.6/93.4)
Parent education ≥ high school, n (%)	29/11 (72.5/27.5)	64/36 (64.0/36.0)	72/34 (67.9/32.1)
Parent general anxiety T-STAI [†]	41.0 (36.3-47.0)	40.5 (34.0-45.8)	42.0 (34.8-46.0)
Parent pre-test S-STAI [†]	39.5 (32.3-43.0)	41.5 (34.0-48.0)	41.0 (34.0-47.3)
Parent post-test S-STAI [†]	38.0 (35.0-44.0)	44.0 (39.0-48.0)	42.5 (37.0-47.0)
CHEOPS score [†]	7.0 (5.3-8.0)	8.0 (6.3-10.0)	7.5 (6.0-10.0)

[†]median (interquartile range).

In children who were 5 years or older, SPT on the back had a higher VAS scores compared to the ones tested on the forearms (2 [0-4] vs 2 [0-2]; $p = 0.005$). There was a significant, but weak, reverse correlation between age and VAS scores in children older than 5 years of age ($r = -0.146$, $p = 0.016$; [Figure 1C](#)). The risk of VAS scores above the median age was low in children with increasing age (OR = 0.85; 95% CI [0.76-0.95]; $p = 0.004$).

Level of anxiety in parents

A significant correlation was found between parents' general anxiety STAI (T-Anxiety) scores, and pre-test and post-test STAI (S-Anxiety) scores ($[p < 0.001, r = 0.486]$ and $[p < 0.001, r = 0.411]$, respectively; [Figure 1A-B](#)).

There was not a significant difference between pre-test STAI (S-Anxiety), and post-test STAI (S-Anxiety) scores within the whole group. However, when we diverged the children in three groups (0-<5 year, 5-<12 years and older than 12 years) the pre-test STAI (S-anxiety scores) were found statistically different, respectively (41 [34-47],

40 [32-47] and 38 [30.5-44] p for trend = 0.016; [Figure 2](#)). We did not find such a trend in parents' general anxiety STAI (T-Anxiety), and post-test STAI (S-Anxiety) scores.

Parent gender was a predominant factor for the increased level of anxiety. Mothers exhibited higher pre-test STAI (S-Anxiety) (41 [34-47] vs 38 [29-42]; $p < 0.001$), STAI (T-Anxiety) (44[38-48] vs 41 [36-46]; $p = 0.004$) and post-test STAI (S-Anxiety) (41.0 [34.0-46.0] vs 35.5 [30.0-43.0]; $p < 0.001$) scores compared to fathers. ([Figure 3A-C](#)).

The difference between pre-test and post-test STAI scores in parents did not differ with respect to the age groups of the children and no risk factors could be found to predict the difference in STAI scores above the median level.

Factors including, parents' age, previous prick testing of the child or the parent and the number of allergens being tested did not affect the level of anxiety of the parents.

Testing site in children also influenced the pre-test STAI (S-Anxiety) scores of parents and they had higher scores when their children were tested on the back; however, it did not reach statistical significance ($p = 0.066$).

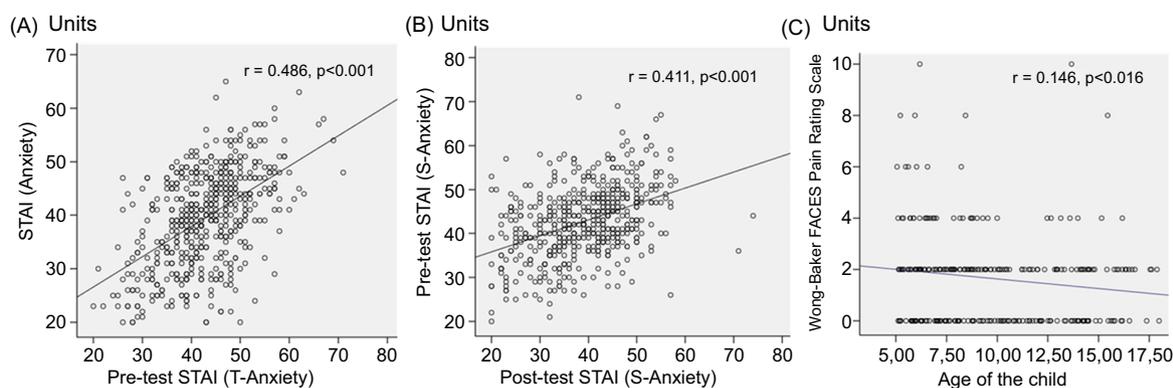


Figure 1 Correlations (A) between general anxiety STAI (T-Anxiety) (scores range from 20 to 80), and pre-test STAI (S-Anxiety) (scores range from 20 to 80); (B) between pre-test STAI (S-Anxiety), and post-test STAI (S-Anxiety); (C) between age and Wong-Baker FACES pain rating scale (scores range from 0 to 10).

Factors related with higher anxiety scores in parents

Risk analysis regarding the general anxiety STAI (T-Anxiety) scores having below or above the median values were performed with univariate and multivariate analyses. The risk factors analyzed were child age, child gender, chronic disease of the child other than atopic diseases, previous prick

testing of the child, number of allergens being tested, the parent's age, the parent's gender, and the parent's education level.

Independent risk factors for high general anxiety STAI (T-Anxiety) scores over the median were female gender of the parent (OR = 1.68; 95% CI [1.10-2.57; p=0.017] and parent's education level being greater than or equal to high school [OR=1.83; 95%CI (1.27-2.64); p=0.001] (Table 3).

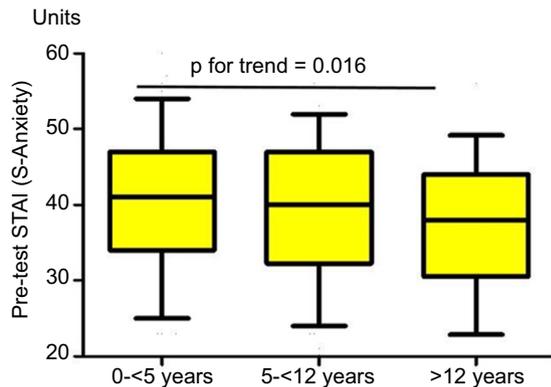


Figure 2 Pre-test STAI (S-Anxiety) scores in parents differed significantly according to the age groups of children. Minimum and maximum pre-test STAI (S-Anxiety) scores range from 20 to 80, defined as units.

Discussion

In the present study, we evaluated the possible predictive factors for the level of pain in children, and the level of anxiety in their parents during the skin prick testing procedure. CHEOPS scores, reflecting perceptual pain of children five years or younger, reached to highest levels between 1 to 3 years of age, and were significantly higher when their mothers had a post-test STAI(S-Anxiety) score above the median level. In children five years or older, skin prick testing on the back had higher VAS scores compared to the ones tested on the forearms; there was a significant but a weak reverse correlation between age, and VAS scores in children older than five years of age. Parents pre-test STAI-S scores decreased in proportion to their child's age. With respect to all STAI scores in parents, mothers experienced higher levels of anxiety compared to fathers. Female sex of parent, and family

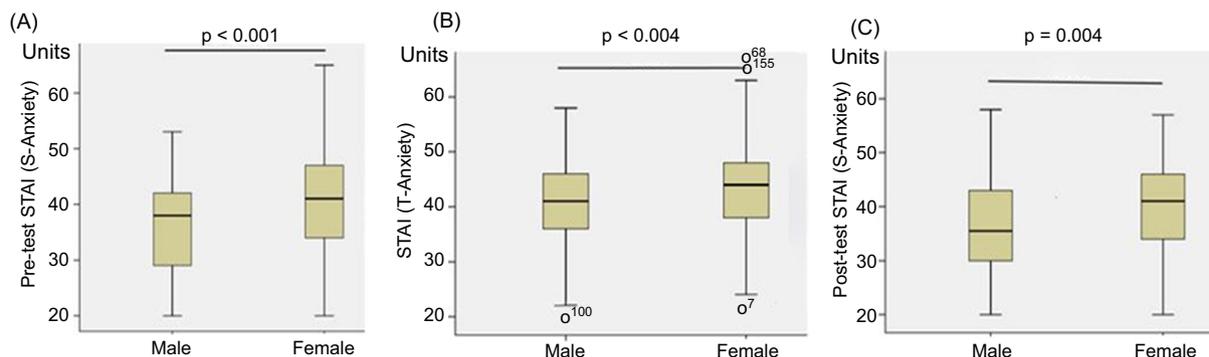


Figure 3 (A) Pre-test STAI (S-Anxiety), (B) STAI (T-Anxiety) and (C) post-test STAI(S-Anxiety) scores were higher in females compared with that in males. Minimum and maximum scores in pre-test STAI (S-Anxiety), STAI (T-Anxiety) and post-test STAI(S-Anxiety) range from 20 to 80, defined as units.

Table 3 Logistic regression analysis regarding the general anxiety scores having above the median level.

	Univariate			Multivariate		
	OR	% 95 CI	p	OR	% 95 CI	p
Child age	1.017	0.978-1.057	0.396			
Gender (girls)	0.958	0.675-1.358	0.808			
Having chronic disease	0.881	0.574-1.350	0.560			
Previous prick testing of the child	0.947	0.669-1.340	0.759			
Parent gender (female)	1.826	1.200-2.779	0.005	1.68	1.10-2.57	0.017
Parent age	1.004	0.980-1.029	0.745			
Parent education \geq high school	1.932	1.348-2.767	<0.000	1.83	1.27-2.64	0.001
Prev. prick testing of the parent	0.900	0.482-1.681	0.742			

education level of high school or more were important risk factors for increased general anxiety.

Pain and anxiety are common in children who needs needle-related procedures, for example injection, routine immunizations and venipuncture. Several studies that have evaluated the interaction between pain, and anxiety in children indicate a positive correlation.^{16,26}

Indeed, children's reactions to pain responses also differs according to their ages.²³ Therefore, different approaches are necessary when coping with the painful procedures. For example, swaddling, and sucking are effective in infants whereas distraction techniques are helpful in older children during medical processes.²⁴

In the present study, pain perception was assessed by CHEOPS scores²² in children under 5 years old after SPT, the highest scores were recorded between 1 to 3 years of age. Infants had lower pain scores when comparing the other age groups of children under five years old. Moreover, in children aged between 1 to 3 years, the pain scores were significantly higher when their mothers had a post-test STAI (S-Anxiety) score above the median level.

Studies demonstrated the close association between parent's anxiety, and child's distress.^{27,28} One explanation for this is behaviors shown in the face of stress, and pain perception usually pass through the family for generations, as children learn by imitating their parents. On the other hand, parental psychological troubles may influence the development of child's attitudes during stressful conditions. Parental symptoms of anxiety, and depression may also affect children's behavior both in the daily life, and during medical interventions.^{27,29}

Many children have no evident problem of pain, while SPT is a minimally invasive treatment. But in a particular subgroup of preschool children aged between 1 to 3 years, it was more difficult to execute the testing procedure. The children in 1 to 3 years of age are in the age of autonomy, which corresponds to stubborn, negative and mobile mixer anchor behaviors. In this era, children have persistent negative, fastening mixer motion and they are full of contradictions in their behavior. It should be kept in the mind that in these ages it is more difficult to convince them to do something.³⁰

Parents pre-test STAI-S scores decreased in proportion to their child's age. With respect to all STAI scores in parents, mothers experienced higher levels of anxiety compared to fathers.

In our study, being female was related with higher anxiety scores. When compared with fathers, mothers have many more worries about their children's general health. Mothers are also more sensitive about their children's medical procedures; especially with regard to interventional procedures. Because of a long-lasting and close relationship with their children during childhood, which starts from birth, mothers' concerns are more intense than fathers. And, also it is more difficult to convince mothers than fathers.³¹

In a preliminary study about maternal anxiety and child fear during dental procedures, the authors demonstrated a correlation with maternal anxiety before children's dental treatment and children's dental fear.⁴

Similarly, in our study, the relation between mother and child influenced the pain score in 1-3 years of age

group. The high anxiety levels of mothers were associated with child's high level of pain perception at the same ages.

And also, Serinken et. al depicted the anxiety scores of mothers and fathers were similar on presentation, in children with acute pediatric blunt head injury who were admitted to emergency department, however mothers' decrease of anxiety scores was significantly lower than that of fathers'.³²

In children older than 5 years of age, pain was assessed by VAS²¹ which is a subjective pain scale, and children whose SPT performed on the back had higher pain scores when compared with children tested on the fore arm. Furthermore, VAS scores were higher in younger children in regardless of the testing site.

In a pilot study distraction for allergy testing conducted among adolescents depicted no differences of pain ratings, lower anxiety was related with lower pain scores.¹⁶ Similarly, in our study there was a significant but a weak reverse correlation between age and VAS scores in children older than five years of age.

There was a tendency to have higher STAI scores if the children were tested on the back when compared with the children tested on forearms. Although, families were instructed about the testing procedure prior to administration, the site of testing may cause anxiety. In the case of skin testing on the back, the impossibility of viewing the procedure we found caused increased fear, and intensification of pain in children, especially in children older than five years of age; this subsequently increased the anxiety of the parents.

Interestingly, parent's education level, namely high school or higher contributed to an increased general anxiety of the parent in our study population. It might be more difficult to convince parents with higher education levels about the ease and the safety of the testing procedure.

We understand according to our findings, giving more attention to lessen anxiety for the parents with high educational level, female gender, and especially with children ages 1-3 is important to get a more comfortable result during prick testing.

Routinely, pediatric allergy clinics do not use pharmacological and/or non-pharmacological methods to alleviate pain and anxiety during SPT in Turkey. Although SPT is a minor medical procedure, it can provoke pain and discomfort in some group of children. Therefore, pain awareness and management are essential to prevent long term damaging impacts on their future pain responses, like the other needle requiring interventions.²⁶

Strengths of this study are the large number of participants in comparison to other studies in the field and the availability of information on many potential confounders. We feel confident that the STAI, VAS and CHEOPS scores have adequate reliability and validity. Furthermore, the determination of VAS and CHEOPS scores were evaluated by the same nurse experienced on this issue.

There are some limitations in the current study, similarly with most of the studies. First, this is a study designed to focus on children, and their parents with complaints of allergic problems; thus, this is a patient-based survey where the results may differ depending on the patient characteristics of the study population, and place where the testing procedure is applied. In fact, the study population

reflects clinical practice, and the main aim of the study is to document what physicians face in their daily clinical practice, and what is the feeling of both parents and children towards the testing procedure.

In conclusion, prick testing may cause anxiety, and pain in a subgroup of children particularly of a younger age, namely between 1 and 3 years of age, and if performed on the back. Anxiety was higher in mothers, and in parents with high education levels. Clinicians should be aware of procedural anxiety, and pain perception during SPT in childhood to prevent negative impacts on future medical procedures.

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Potential conflict of interest

The authors have indicated they have no potential conflicts of interest to disclose.

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