Peak Inspiratory Flow Rate and the Ability to Use the Turbuhaler in Thai Children Aged 3-7 Years

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Abstract

A Turbuhaler is a dry powder inhaler device commonly used by asthmatic patients. Its superiority over a metered-dose inhaler device includes easy technique, convenience in handling and absence of chloro fluoro carbon (CFC). However, the use of this device has some limitations in young children who may not be able to generate the inspiratory flow rate high enough to assure adequate medication delivery. Even though the Turbuhaler has been used in Thailand for many years, the study of inspiratory flow rate and the ability to use this device in Thai preschool children is lacking.

In the present study, the authors aimed to evaluate the ability to use the Turbuhaler in Thai preschool children by measuring the peak inspiratory flow rate, peak inspiratory flow rate through the Turbuhaler as well as positive test of the Turbutester. Subjects included 468 Thai preschool children, aged 3-7 years old. They were assigned to perform the test with In-Check Dial, Mini-Wright Peak Flow Meter and Turbutester. The authors found that the ability to use the device correlated directly with age and children with age of 5 years or more could perform significantly better. Children weight of 20 kilograms or more, or a height of 113 centimeters or more were also able to generate adequate inspiratory flow rate for medication delivery.

The authors concluded that children from the age of five years, or with a weight from 20 kilograms or a height from 113 centimeters were able to generate adequate inspiratory flow rate for effective medication delivery by the Turbuhaler.

Key word : Asthma, Dry Powder Inhaler, Turbuhaler, Inspiratory Flow Rate

TANTIBHAEDHYANGKUL U, CHATCHATEE P, CHOKETEERASWAD T, NGAMPHAIBOON J
J Med Assoc Thai 2003; 86 (Suppl 2): S201-S207

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Inhalation medication has been the mainstay of asthma treatment in recent years. Dry powder inhalers (DPIs) are being used more often for the administration of asthma medication in pediatric age group. They were developed to overcome problems associated with the use of pMDIs[1,2]. The Turbuhaler is a dry powder inhaler device which delivers an aerosal of micronized drug[3]. Its superiority includes easy technique, convenience in handling and absence of CFC[4-6]. However, the use of this device has some limitations in young children who cannot generate an adequate inspiratory flow. The Turbuhaler has been used in children starting from age 3-6 years[7-10]. According to the studies by Engel et al and Pedersen et al, the Turbuhaler requires an inspiratory flow of at least 30 L/min to produce sufficient medication delivery[8,11] Goren et al found that 79, 92 and 100 per cent of 4, 5 and 6-year old children demonstrated clinical improvement of asthma symptoms after inhalation *via* the Turbuhaler[9]. Even though the Turbuhaler has been used in Thailand for many years, a study about inspiratory flow rate, which will assure proper medication delivery in Thai preschool children, is lacking. The authors studied the peak inspiratory flow rate (PIF), peak inspiratory flow rate through the Turbuhaler (PIF-TH) and their relationships with age, weight, height and peak expiratory flow rate (PEF) to determine the ability of Thai children to use the Turbuhaler and establish appropriate guide lines for using this device.

MATERIAL AND METHOD

The authors enrolled students, aged 3-7 years, from one primary school in Bangkok. The parents were informed and their permission was asked to allow their children to participate in the study. Consent forms were distributed to parents of 518 students and 468 students were allowed to participate. The students were asked to use three devices; a Turbutester, In-Check Dial and Mini-Wright Peak Flow Meter. The Turbutester is a Turbuhaler like device used to evaluate the ability to use the Turbuhaler in children. In-Check Dial is an instrument used to assess PIF and PIF-TH, with an accuracy of ± 10 per cent or 10 lit/minute (whichever is the greater). Repeatability of ± 5 lit/minute is considered acceptable. A Mini-Wright Peak Flow Meter is used to measure PEF. All of the subjects were taught to use these devices in small groups of not more than thirty, to ensure the understanding of use. Every student performed each of the tests three times. The maximum values were used for subsequent analysis.

Demographic data are shown in mean, median and per cent. Independent sample *t*-test and Pearson Chi square were used to evaluate the statistical differences of quantitative and qualitative measures between the groups. Pearson correlation was used to analyze the linear relationship between PIF, PIF-TH, PEF and demographic data. SPSS version 9.0 was used for data analysis.

RESULTS

There were 468 subjects, 222 males and 246 females in the study. Ages ranged from three to seven years (Table 1). The average weight and height are shown in Table 2. Fig. 1 shows PIF and PIF-TH according to age groups. Both PIF and PIF-TH were correlated with age. PIF rates were significantly higher than their corresponding PIF-TH ($p < 0.05$). The average PIF rates were 64, 99, 116, 123, 127 L/min

Table 1. Age and gender distribution of the population tested.

Age (years)	Male (n)	Female (n)	Total
3-3.99	46	46	92
4-4.99	51	53	104
5-5.99	54	48	102
6-6.99	32	50	82
7-7.99	39	49	88
Total	222	246	468

Table 2. Weight and height of children in each age group.

Age (years)	Weight (kg)		Height (cm)	
	Mean	Median	Mean	Median
3-3.99	16.56	16	100.15	100
4-4.99	18.55	18	107.04	106
5-5.99	20.95	20	113.31	114
6-6.99	22.68	21	118.25	118
7-7.99	26.46	24	124.01	124
Total	20.89	20	112.21	113

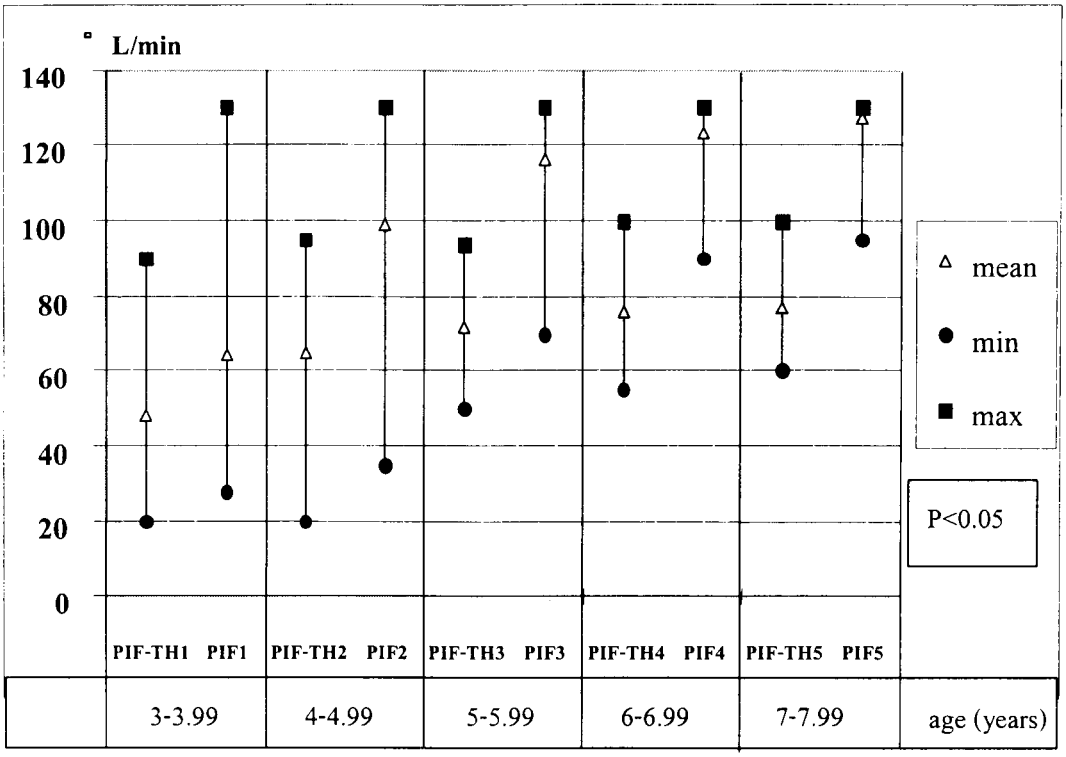

Fig. 1. PIF-TH and PIF in each age group.

and mean of the PIF-TH was 48, 65, 72, 76, 77 L/min respectively for each age group. The correlation coefficients of PIF-TH with PIF and of PIF-TH with PEF were 0.844 and 0.665 respectively (data not shown).

The authors found that the percentage of children who passed the Turbutester test increased consistently with age as presented in Fig. 2 ($p < 0.05$). The percentage of children who were able to perform the test increased significantly from the age of five with more than 90 per cent of the children were being able to use the Turbutester. This finding was also the same as the ability to perform the PIF and PIF-TH test as shown in Fig. 3 and 4. ($p < 0.05$). The age of five years was found to be critical to the ability of the subjects to perform all of the tests successfully. The correlation between weight, height or gender of the students and their ability to perform the PIF, PIF-TH and PEF tests was also evaluated. Children with a weight of 20 kilograms or more, or height of 113 centimeters or more, were able to perform all three tests better than the ones with lower weight or height ($p < 0.05$) (Table 3). Gender had no effect on the test ($p > 0.05$).

The correlations between measured pulmonary function (PIF, PIF-TH and PEF) and age, weight and height are shown in Table 4. The correlations were found to be higher with age and height than with weight.

DISCUSSION

The effective medication delivery *via* a Turbuhaler depends on adequate inspiratory flow rate. In order to assess the ability of young Thai children to use this device, the authors measured PIF, PIF-TH and PEF in Thai children aged 3-7 years, and found that they had an average PIF-TH of 69 L/min. This is comparable to the value in Caucasian children (58-60 L/min)[7]. PIF-TH was found to be significantly lower than PIF. This is in agreement with the findings by Engel et al[11]. A study by Pedersen S et al

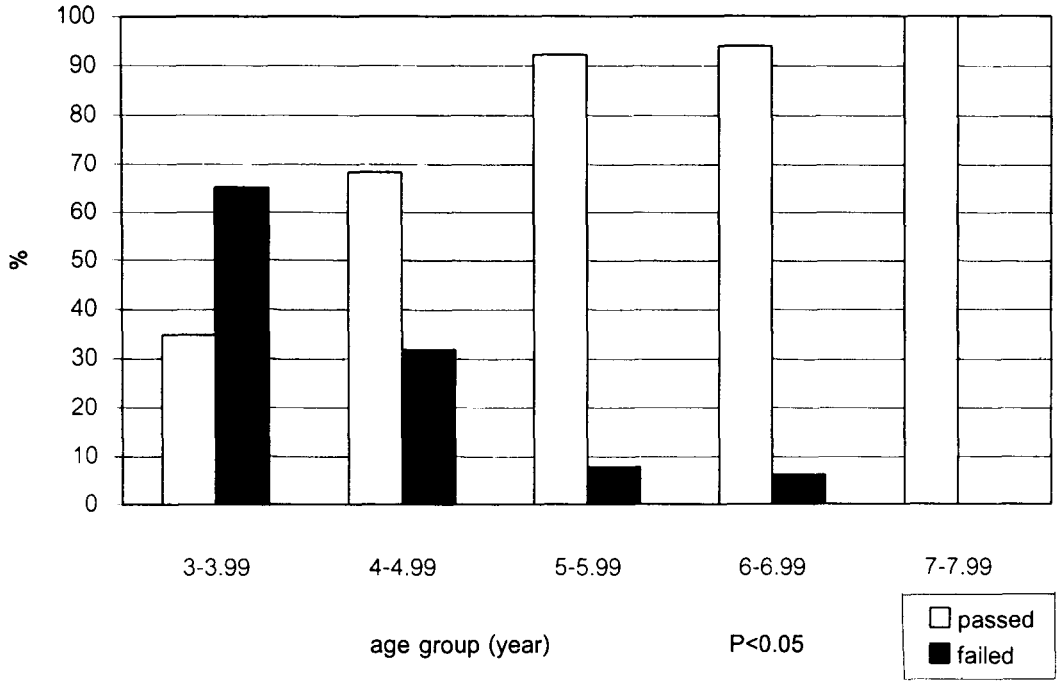

Fig. 2. Ability to use a Turbuhaler according to age.

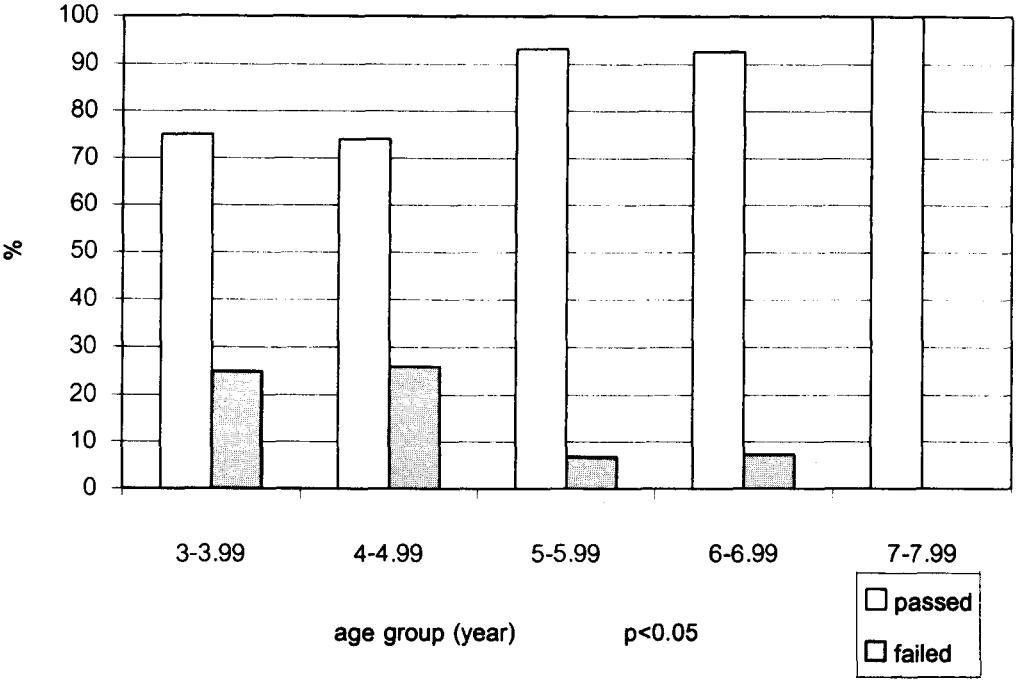

Fig. 3. Ability to perform PIF test in each age group.

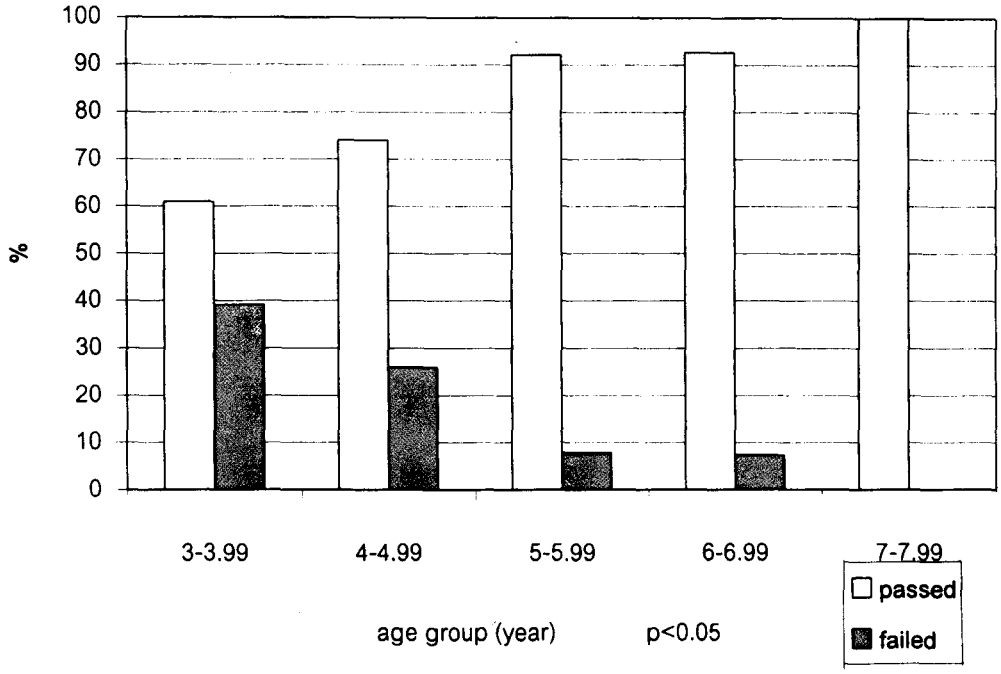

Fig. 4. Ability to perform PIF-TH test in each age group.

Table 3. Ability to perform the tests (PIF, PIF-TH, PEF) according to weight, height and gender.

	PIF	PIF-TH	PEF
Weight < 20 kgs *vs* ≥ 20 kgs	$p < 0.05$	$p < 0.05$	$p < 0.05$
Height < 113 cm *vs* ≥ 113 cms	$p < 0.05$	$p < 0.05$	$p < 0.05$
Gender (male-female)	$p > 0.05$	$p > 0.05$	$p > 0.05$

Table 4. Correlations between the tested values (PIF, PIF-TH, PEF) and age, weight, and height.

	Age	Weight	Height
PIF	$r = 0.738$, $p < 0.01$	$r = 0.486$, $p < 0.01$	$r = 0.738$, $p < 0.01$
PIF-TH	$r = 0.569$, $p < 0.01$	$r = 0.459$, $p < 0.01$	$r = 0.593$, $p < 0.01$
PEF	$r = 0.767$, $p < 0.01$	$r = 0.578$, $p < 0.01$	$r = 0.784$, $p < 0.01$

(8) demonstrated that PIF correlated with age ($r = 0.83$; $p < 0.01$) and with PEF ($r = 0.90$; $p < 0.01$). Brown et al(4) also found correlation between PIF and PEF ($r = 0.69$; $p < 0.001$). In the present study, the authors analyzed the correlations between the measured pulmonary functions (PIF, PIF-TH and PEF) and certain parameters (age, height and weight). Higher correlations were found with age and height. Even though PIF-TH correlated more with the measured pulmonary function (PIF and PEF), it is more con-

venient to use age, weight or height to calculate PIF-TH and to assess the ability of children to use a Turbuhaler. The present data indicated that children from the age of five could perform all tests significantly better. The authors also found that weight and height may also be used as indicators of the child's ability to use a Turbuhaler. It was concluded that Thai children from the age of five years, or with a weight from 20 kilograms or height from 113 centimeters were able to generate adequate inspiratory flow rate for effective medication delivery by Turbuhaler. This finding will be helpful in selecting the appropriate device for asthma medication delivery in Thai children.

(Received for publication on April 6, 2003)

REFERENCES

1. Jackson L, Stahl E, Holgate ST. Terbutaline *via* pressurized metered-dose inhaler (pMDI) and Turbuhaler® in highly reactive asthmatic patients. Eur Respir J 1994; 7: 1598-601.
2. Pedersen S, Frost L, Anfred T. Error in inhalation technique and efficacy in inhaler use in asthmatic children. Allergy 1986; 41: 118-24.
3. Wetterlin K. Turbuhaler: A new powder inhaler for administration of drugs to airways. Pharmacol Res 1988; 5: 506-8.
4. Brown PH, Ning ACWS, Greening AP, McLean A, Crompton GK. Peak inspiratory flow through Turbuhaler® in acute asthma. Eur Respir J 1995; 8: 1940-1.
5. Bisgaard H, Klug B, Sumby BS, Burnell KP. Fine particle mass from the diskus inhaler and Turbuhaler inhaler in children with asthma. Eur Respir J 1998; 11: 1111-5.
6. Nielsen KG, Auk IL, Bojsen K, Ifversen M, Klug B, Bisgaard H. Clinical effect of Diskus™ dry-powder inhaler at low and high inspiratory flow-rates in asthmatic children. Eur Respir J 1998; 11: 350-4.
7. Stahl E, Ribeiro LB, Sandahl G. Dose response to inhale turbutaline powder and peak inspiratory flow through Turbuhaler® in children with mild to moderate Asthma. Pediatr Pulmonol 1996; 22: 106-10.
8. Pedersen S, Hansen OR, Fuglsang G. Influence of inspiratory flow rate upon the effect of a Turbuhaler. Arch Dis Child 1990; 65: 308-10.
9. Goren A, Noviski N, Avital A, et al. Assessment of the ability of young children to use a powder inhaler device (Turbuhaler). Pediatr Pulmonol 1994; 18: 77-80.
10. Laberge S, Spier S, Drblik SP, Turgeon JP. Clinical and laboratory observations : Comparison of inhaled turbutaline admininstered by either the Turbuhaler dry powder inhaler or a metered-dose inhaler with spacer in preschool children with asthma. J Pediatr 1994; 124 part 1: 815-7.
11. Engel T, Heinig JH, Madsen F, Nikander K. Peak inspiratory flow and inspiratory vital capacity of patients with asthma measured with and without a new dry-powder inhaler device (Turbuhaler®). Eur Respir J 1990; 3: 1037-41.

การศึกษาความสามารถในการใช้ Turbuhaler ของเด็กไทยอายุ 3–7 ปี

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Turbuhaler เป็นอุปกรณ์ที่ใช้ในการบริหารยารักษาหอบหืด ที่นิยมใช้อย่างแพร่หลาย เพราะใช้ง่าย สะดวกต่อการพกพา และไม่ทำลายชั้นบรรยากาศ แต่อาจมีข้อจำกัดในเด็กเล็ก เพราะต้องอาศัยความเร็วของแรงสูดหายใจเข้าที่มากพอ สำหรับในประเทศไทยมีการใช้ turbuhaler อย่างแพร่หลาย ยังไม่มีข้อมูลที่แสดงให้เห็นว่า Turbuhaler สามารถใช้ได้อย่างมีประสิทธิภาพในเด็กไทยตั้งแต่อายุเท่าไร ผู้วิจัยมีวัตถุประสงค์เพื่อประเมินความสามารถในการใช้ Turbuhaler ของเด็กนักเรียนช่วงอายุ 3–7 ปี โดยการวัดค่า peak inspiratory flow rate (PIF), peak inspiratory flow ผ่าน Turbuhaler (PIF–TH) และประเมินความสามารถในการใช้ Tubutester ของเด็กนักเรียน จำนวน 468 คน อายุ 3– 7 ปี ในโรงเรียนแห่งหนึ่งในกรุงเทพมหานคร โดยเครื่องมือที่ใช้ประกอบด้วย In–Check Dial, Mini Wright Peak Flow Meter และ Turbutester ผลการวิจัยพบว่าความสามารถในการใช้อุปกรณ์รวมถึงค่า PIF และ PIF– Turbuhaler จะสัมพันธ์โดยตรงกับอายุที่เพิ่มขึ้น โดยเฉพาะเด็กมีอายุตั้งแต่ 5 ปีขึ้นไป จะมีความสามารถใช้อุปกรณ์ได้ดีขึ้นอย่างมีนัยสำคัญทางสถิติ เมื่อเทียบกับเด็กที่มีอายุน้อยกว่านี้ และมีค่า PIF–TH สูงเพียงพอต่อการใช้ Turbuhaler ได้อย่างมีประสิทธิภาพ นอกจากนี้พบว่าเด็กที่มีน้ำหนักตั้งแต่ 20 กิโลกรัม หรือมีส่วนสูงตั้งแต่ 113 เซนติเมตรขึ้นไป มีความสามารถในการใช้ Turbuhaler ได้อย่างมีประสิทธิภาพ เมื่อเปรียบเทียบกับเด็กที่มีน้ำหนักและส่วนสูงน้อยกว่านี้ อย่างมีนัยสำคัญทางสถิติด้วย

ข้อมูลจากการวิจัยนี้บ่งชี้ว่า Turbuhaler สามารถใช้ในเด็กไทย อายุตั้งแต่ 5 ปีขึ้นไป หรือในเด็กไทยที่มีน้ำหนัก ตั้งแต่ 20 กิโลกรัม หรือมีส่วนสูงตั้งแต่ 113 เซนติเมตร ได้อย่างมีประสิทธิภาพ

คำสำคัญ : หอบหืด, ยาสูดชนิดผง, เทอร์บูเฮลเลอร์, อัตราความเร็วลมหายใจเข้า

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