Paper : Physiology

The Comparison of Respiratory Functions in those with or without a Past Medical History of Bronchial Asthma during Soccer Games in Physical Education Classes under Cold Temperature

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The purpose of this study was to investigate changes in the indices of respiratory functions during soccer games for three times in physical education classes in individuals with past medical histories of bronchial asthma. Eleven male students with a past medical history of bronchial asthma (=Asthma group) and eleven controls played the soccer game (15 minutes) in physical education classes, in December 2010 (Temperature: 6.8 ℃, Relative humidity: 38.9 %), Japan. They played soccer games for three times, and each game was 15 minutes. We took break for approximate 10 minutes between each game.
Participant's $FEV_{1.0}$, PEF and SpO_2 were measured before the class (Rest) and at the time 5 minutes after each game. We suggested that stress on respiratory system indicated greater during playing a soccer game for 15 minutes in physical education classes under cold environment in individuals with past medical histories of bronchial asthma.

Keywords: Bronchial asthma, Soccer, $FEV_{1.0}$, Physical education

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1. Introduction

Bronchial asthma is respiratory disease of invertible airway obstruction from various initiating factor. Allergens and exercise have received the most attention. Both are powerful, naturally occurring precipitants, but exercise is a potential factor in the daily life of ever asthmatic, whereas allergens only affect some persons with bronchial asthma (Ricardo et al., 2002). In Japan, the rates of asthmatic person keep rising in late years (Japanese Society of Allergology, 2012). Exercise has often been the first trigger for asthma attacks experienced by asthmatic persons. Exercise induced-asthma (EIA) occurs in 40 to 90 % of asthmatic patients and in 6 to 13 % of the general population. From the aspects of Japanese school health, EIA attack is one of the social problems in physical education class (Japanese Society of Pediatric Allergy and Clinical Immunology, 2012). Japanese Society of Pediatric Allergy and Clinical Immunology (2012) indicated students from elementary school to high school with bronchial asthma developed asthma attack during high intensity exercises such as soccer and running.

There are many studies in EIA, most of them have been conducted in experiment room under an artificially-tuned environment conditions (Deal et al., 1980; Strauss et al., 1978; Shinomiya et al., 1981). On the other hand, it has been generally believed that there is relationship between asthma attack and meteorological conditions (Japanese Society of Allergology, 2012). The inhalation of cold and dry air is known to affect the respiratory system, and an attack of asthma may be provoked by the inhalation

of cold or dry air. Furthermore, physical activity in dry and cold environment may elicit acute asthmatic exacerbations and / or increase the bronchial response to a nonspecific challenge in hyperresponsive subjects (Cogo et al., 1997). For a majority of persons with bronchial asthma, physical activity is an important trigger of asthma attacks. People in the mountains often exercise and even if EIA may occur in any climatic condition it increases substantially during breathing dry cold air (Cogo et al., 1997; Takagi et al., 2011). According to epidemiological research of Ishizaki et al. (1974), they picked especially adduced reduction of temperature as meteorological factors. Deal et al. (1980) suggested that temperature difference on an exercise in cold environment caused enhancement of airway reactivity and then increased risks of asthma attack. Physical education in Japanese school is outside ground in many cases. Students receive not only exercise intensity but also meteorological variation in physical education class. However, there has been no report suggesting that the actual situation of changes in respiratory functions in physical education classes for asthmatic diathesis persons. Especially, respiratory functions data of subjects in adolescence students have been no report not in an actual physical education class but in an experimental room.

The purpose of this study is to investigate changes in the indices of respiratory functions in individuals with past medical histories of bronchial asthma during soccer games in physical education classes under cold temperature.

2. Methods

2.1. Subjects

Eleven Japanese healthy male students with a past medical history of bronchial asthma (=Asthma group. age: 18.3 ± 0.5 years, height: 167.8 ± 5.5 cm, weight: 61.9 ± 7.8 kg) and eleven healthy control students (=Non-asthma group: age: 18.6 ± 0.5 years, height: 168.6 ± 5.3 cm, weight: 60.2 ± 9.4 kg) volunteered to play the soccer game in physical education classes, in December 2010. The students were four grade students in national college of technology. All participants' members in Asthma group developed bronchial asthma in childhood by clinical diagnosis, and they have past medical histories of EIA. They had taken β2 stimulator when EIA developed. They have developed EIA until high school student, but rarely occur in present. None had a history of all respiratory disease including bronchial asthma in Non-asthma group.

We conducted 3,000-meter trial as measurement of physical fitness. Results of this, there were no significant difference between the 2 groups (Asthma group vs. Non-asthma group: 15'42'' ± 2'51'' vs. 15'07'' ± 2'14'').

Informed consent was obtained from all participants after explaining the study purpose and potential risks on this study protocol. Thus, each participant voluntarily joined this program. This study was approved by institutional (Kawasaki University of Medical Welfare) review board.

2.2. Investigation contents

Figure 1 shows the protocol of this investigation. We measured the indices in the classroom (25~28 ℃) after the class. Then, the subjects went out the classroom the same as other students during a break (10 minutes). The investigation began at the same time as the class bell. At the beginning of the class, the physical education teacher took attendance in the class member, after that the students performed moderate stretching, and running a lap of the 400-meter track at their pace as warm-up (approximate 10 minutes). The students were split into four teams and they played soccer games for three times, and each game was 15 minutes. The game was set up a 11-on-11 game. Soccer games were in the half divided ground that each court was approximately 50 m horizontal × approximately 80 m vertical pitch size respectively. This study was conducted in regular physical education class. We adopted the member of each team devised by physical education representative each class. The team member was the same in three times games. Class time is 90 minutes. In the physical education curriculum of this school, soccer game is played for 15 minutes including twice 10 minutes break. All teams are able to battle the other teams.

We took breaks for approximate 10 minutes between each game. Atmospheric temperature was 6.8 ± 0.4 ℃, and relative humidity was 38.9 ± 0.8 % in average values respectively. They were measured at the beginning of each game.

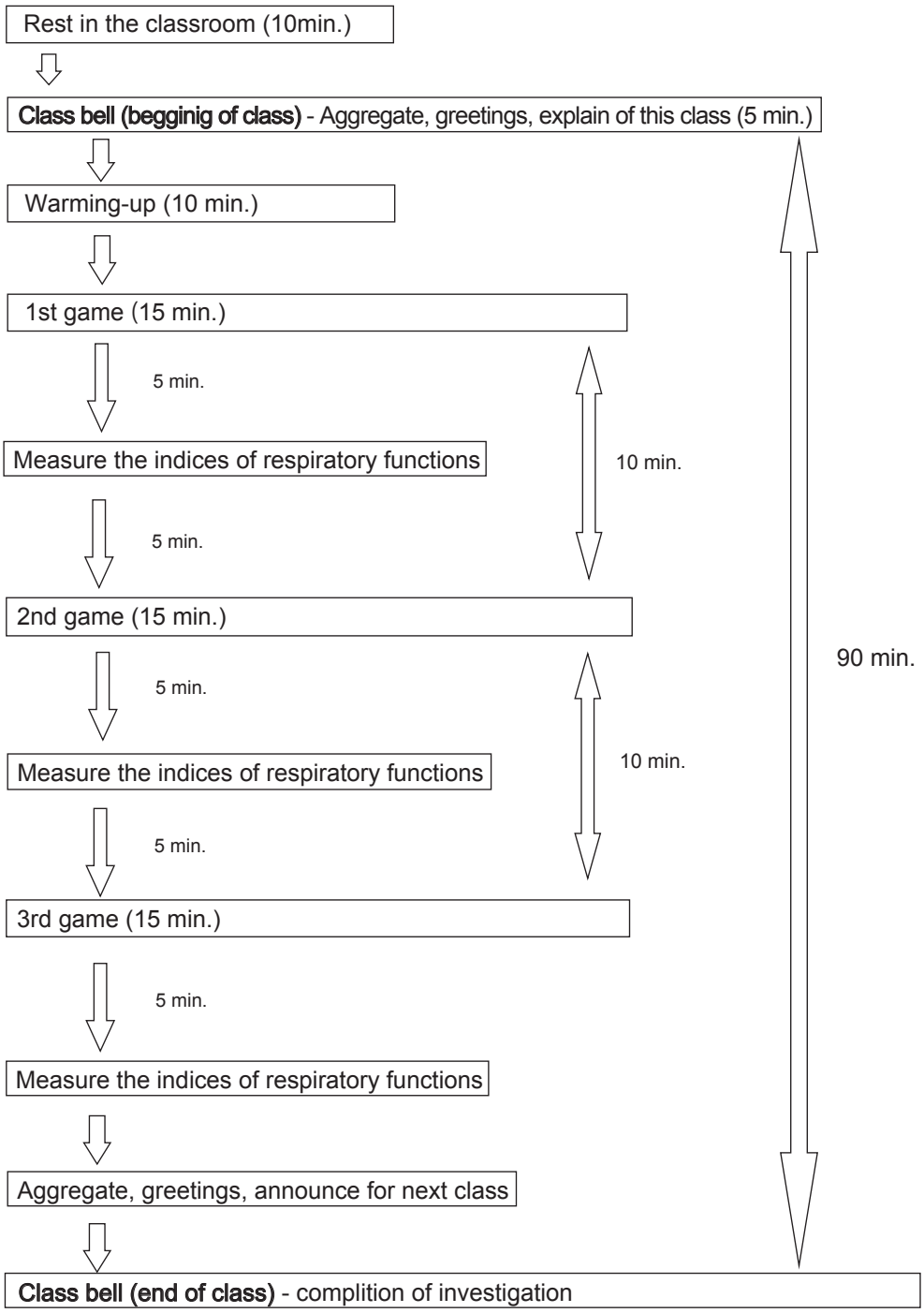

Figure 1 Protocol of this investigation

2.3. Measurements

Participant's forced expiratory volume in one second ($FEV_{1.0}$), peak expiratory flow (PEF), percutaneous arterial blood oxygen (SpO_2), the degree of dyspnea sensation (DDS) and heart rate (HR) were measured before the class (Rest: 10 minutes break before the class in classroom) and at the time 5 minutes after each game (After-1·After-2·After-3). HR was recorded by the minute. Measurement of $FEV_{1.0}$ and PEF were used by spirometer (micro; Vitalograph®). We had the subjects perform maximum forced exhalations in twofold with a spirometer. SpO_2 was measured by pulse oximeter (SAT-2100; NIHONKODEN®) and that of HR was heart rate monitor (Rs800; POLAR®). We used modified Borg scale (Borg, 1982) to measure the DDS in this study. Borg scale for DDS indicates 0 ~ 10 scale (0: Nothing at all, 0.5: Very, very weak, 1: Very weak, 2: Weak, 4: Somewhat strong, 5: Strong, 7: Very strong, 10: Very,

very strong). The subjects answered orally this scale. EIA is usually preceded by at least 3 to 8 minutes of exercise. Bronchospasm and / or symptoms of chest tightness, cough, wheezing, and dyspnea start soon after the end of exercise and peak in approximately 8 to 15 minutes (Godfray, 1973). In this study, we measured the indices of respiratory functions at 5 minutes after soccer game.

2.4. Statistical analysis

The data ($FEV_{1.0}$, PEF, SpO_2) were presented as mean ± standard deviation. DDS were indicated as median.

It is need to compare the indices of respiratory functions between the 2 groups and within the group with or without a past medical history of bronchial asthma. Therefore, we analyzed with repeated measure two-way analysis of variance to examine differences between the means of two groups. If it was recognized significant interactions, we would analyze the data by simple main effects test. And we conducted post hoc test (Bonferroni) only in the case that if it was recognized significant simple main effects test. Wilcoxon's signed rank test was performed to detect changes of DDS within each group. Statistical significance was accepted less than 0.05. The data were analyzed by SPSS ver. 12.0 for Windows.

3. Results

Figure 2 shows changes in the HR during soccer games. HRmax in all subjects indicated over 170 bpm. Both groups in HRmax indicated high score; 1st game (Asthma: 186 ± 4 bpm, Non-asthma: 189 ± 15 bpm), 2nd game (Asthma: 186 ± 10 bpm, Non-asthma: 192 ± 13 bpm) and 3rd game (Asthma: 189 ± 8 bpm, Non-asthma: 191 ± 8 bpm). Mean HR per minute (range of 15 minutes) were 1st game (Asthma: 114 ~ 176 bpm , Non-asthma: 114 ~ 181 bpm), 2nd game (Asthma: 156 ~ 178 bpm, Non-asthma: 161 ~ 184 bpm), 3rd game (Asthma: 152 ~ 175 bpm , Non-asthma: 159 ~ 180 bpm). No significant differences were found on HRmax, HR (After1 ~ After3) changes between the two groups.

Table 1 shows changes in $FEV_{1.0}$, PEF, SpO_2 and DDS. There were recognized significant interactions in $FEV_{1.0}$ ($F(3, 60) = 4.411$, $p<0.01$), PEF ($F(3, 60) = 6.515$, $p<0.01$) and SpO_2 ($F(3, 60) = 4.085$, $p<0.01$) changes. Results of post hoc test, significant reductions in $FEV_{1.0}$, PEF and SpO_2 were observed at the After-1 in Asthma group ($p<0.05$, Table 1). No significant differences were found on $FEV_{1.0}$, PEF and

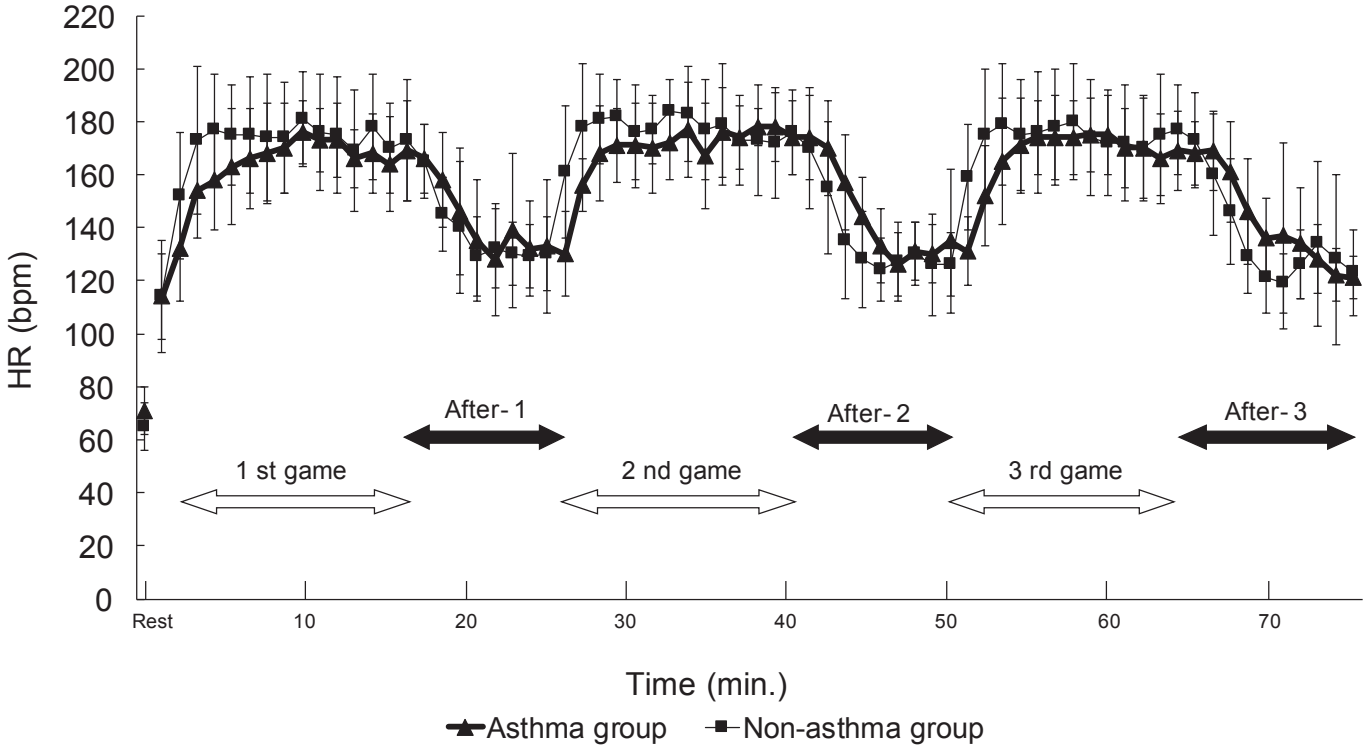

Figure 2 Changes in the heart rate (HR) during soccer games Asthma group vs. Non-asthma group (Not significant)

Table 1 Changes in $FEV_{1.0}$, PEF, SpO_2 and DDS

Index	Asthma group (n=11)				Non-asthma group (n=11)			
	Rest	After- 1	After- 2	After- 3	Rest	After- 1	After- 2	After- 3
$FEV_{1.0}$ (L)	3.59 ± 0.42	3.14 ± 0.23	3.31 ± 0.5	3.56 ± 0.81	3.66 ± 0.53	3.74 ± 0.64	3.97 ± 0.49	4.02 ± 0.6
PEF (L / min)	480 ± 77	427 ± 95	452 ± 59	432 ± 87	505 ± 110	534 ± 96	531 ± 82	555 ± 84
SpO_2 (%)	98 ± 1	95 ± 1	96 ± 2	96 ± 1	97 ± 1	97 ± 1	97 ± 1	97 ± 1
DDS	0	4	3	4	0	3	3	1

$FEV_{1.0}$ = Forced Expiratory Volume in One Second: Mean ± SD
PEF=Peak Expiratory Flow:Mean ± SD
SpO_2 =Percutaneous Arterial Oxygen Saturation: Mean ± SD
DDS=The Degree of Dyspnea Sensation:Median

$FEV_{1.0}$ PEF & SpO_2: Asthma group; Rest vs. After-1 ($p<0.05$)
DDS: Asthma & Non-asthma group;
Rest vs.After-1 · 2 and After-3(Asthma group) ($p<0.05$)

SpO_2 in Non-asthma group (**Table 1**).

There were no significant changes in measured value at Rest between the 2 groups. Significant reductions in $FEV_{1.0}$, PEF, SpO_2 were observed at the After-1 in Asthma group ($p<0.05$). Max%fall of $FEV_{1.0}$ in Asthma group indicated 11.9 ± 4.8 % after the first game. No significant differences were found on them in Non-asthma group. DDS at the After-1, After-2 and After-3 (Asthma group) were significantly higher than that at the Rest in Asthma group (After-1: 4, After-2: 3, After-3: 4) and Non-asthma group (After-1: 3, After-2: 3) ($p<0.05$). Asthma group demonstrated lower each measurement ($FEV_{1.0}$, PEF, SpO_2) at the After-1 as compared with the values of Non-asthma group.

4. Disccusion

We examined changes in indices of respiratory functions ($FEV_{1.0}$, PEF, SpO_2 and DDS) during soccer games in physical education classes in individuals with past medical histories of bronchial asthma. Based on the result, Asthma group significantly demonstrated lower $FEV_{1.0}$, PEF and SpO_2 after the games compared with values of rest and that of Non-asthma group. Max%fall of $FEV_{1.0}$ in Asthma group indicated similar in asthma positive level (over 15 %) (Japanese Society of Allergology, 2012). DDS after the games in both groups were significantly higher than that at rest. In addition, asthma group demonstrated lower $FEV_{1.0}$, PEF and SpO_2 at the After-1 as compared with the values of Non-asthma group.

As high intensity exercise of aerobic and anaerobic, soccer game increased stress on the respiratory system with apparent increases in oxygen demand. The previous study reported that soccer players run more than approximately 500 meter in 5 minutes (Miyamori et al., 2008). In Asthma group, HR heavily increased during the soccer games and SpO_2 significantly reduced when the first game were over in this study. Compared with the values of Non-asthma group, Asthma group significantly demonstrated lower $FEV_{1.0}$, PEF and SpO_2 in After-1. These indicated that Asthma group received heavy stresses on the respiratory system.

Airway obstruction was induced by increase of oral-breathing which led by increase of oxygen demand during exercise in cold environment (Takagi et al., 2010). For these reasons, it was considered that significant decrease in $FEV_{1.0}$ and PEF in after the games indicated enhancing airway reactivity induced by additive effects of increase of oral-breathing from high-intensity exercise and exposure to cold environment (6 ℃) from classroom (25 ~ 28 ℃). Though conditions in Asthma group after the games indicate mild asthma attack in clinical estimation, it was in safety range of exercise in Japan.

Considering additive stresses in exposure to cold temperature from classroom and increase of exercise intensity in physical classes, it needs to play warming up before main exercise. Students play physical exercise in mild intensity and resistance training (for example: push up, sit ups exercise to strengthen abdominal muscles and back muscles) after a beginning of physical class in Japanese school. Then,

attentions should be played to aerobic exercise in middle intensity.

If the asthmatic person attempts to exercise again after the symptoms subside, they will experience less symptoms the second time (Ricardo et al., 2002). This has been referred to as the refractory period. The duration of this period has been observed by different authors to be anywhere from 40 minutes to up to 3 hours (O'Byrne & Jones, 1986; Ricardo et al., 2002). Because of this, it indicates that EIA might be inhibited by implementing aerobic warm-up exercise showing the intensity from mild to middle before the main exercise in the case that the main exercise is high intensity.

5. Conclusion

These data suggest that stress on respiratory system indicated greater during playing a soccer game for 15 minutes in physical education classes under cold environment in individuals with past medical histories of bronchial asthma. It should be played aerobic exercise in middle intensity before main exercise, because of phenomenon which individuals with asthma once developed EIA, they will experience less symptoms the second time that has been referred to as the refractory period.

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