HYPERTENSION AND FULL CONTACT KARATE: ANXIETY OR PATHOLOGY?

JS. BAKER, MR. GRAHAM, B. DAVIES

Health and Exercise Science Research Laboratory, School of Applied Science, University of Glamorgan, Pontypridd, Wales, UK, CF37 1DL

ABSTRACT

Baker JS, Graham MR, Davies B. Hypertension and Full Contact Competitive Events: Anxiety or Pathology? JEPonline 2006;9(3):1-8. The aim of this study was to identify hypertension in karate competitors (KC) at rest, pre-competition, during a routine medical examination prior to the event and at 1, 2 and eight minute intervals post event. The values obtained were compared with an age matched exercise control group (EC). Male subjects (n=84) were divided into two groups: KC (n=43, mean ± SD, age 30.1±1.3 years; height 1.74±0.01 m, weight 78.9±1.9 kg) and EC (n=41, mean ± SD, age 31.2±1.4 years; height 1.73±0.01 m, weight 79.1±2.1 kg). Resting blood pressure (BP) measurements were obtained on two occasions by a physician. The first measurement was taken the evening before the event and the second on the morning of the competition itself. The second measurements were performed as part of a routine medical examination. A further three measurement were taken post exercise for all subjects at 1, 2 and eight minute intervals. At rest, day 1, the mean BP of KC was 134/84±3/2 mmHg and on day 2, was 141/79±3/2 mmHg vs. EC, 124/72±1/2 mmHg, and 125/72±1/2 mmHg, respectively. Eight minutes post-competition, the BP of KC, BP was 140/77±2/1 mmHg and of EC was 135/75±2/1 mmHg. High blood pressure (HBP) was recorded in 60.5% of KC on day 2 and essential hypertension was subsequently diagnosed by their own general practitioners in 5% (n=2) of KC, which required medical therapy. Five percent of the EC also had HBP recorded, but subsequent medical examination reported normal values. Anxiety induced hypertension can mask essential hypertension in recreational activities. Medical practitioners, researchers and governing bodies of sport need to be aware of this finding if a potential health hazard is to be avoided.

Key Words: Cardiovascular, High Intensity Exercise, Hypertension.
INTRODUCTION

Hypertension is the most common cardiovascular disease (CVD) affecting individuals who regularly participate in sport and any treatment of hypertension should consider if individual patients participate regularly in a competitive physical environment (1). Blood pressure normally returns to baseline in normotensive subjects within 8 minutes (1). Some sporting activities, particularly high intensity activities such as resistance power lifting, requiring maximal contractions and exertions may be dangerous for hypertensive individuals and should be avoided (2). Other sporting activities such as low intensity aerobic exercise, such as jogging, may be recommended and are considered an independent or adjunctive treatment for hypertension (HT) (1).

Van Camp et al., (1995) (2) described 160 cases of non-traumatic cardiovascular causes for death in high school and college athletes between 1983 and 1993. The age range of these subjects was 13 to 24 years. Maron et al., (1996) (3) described the clinical profile of 134 athletes who had cardiovascular causes of sudden death between 1985 and 1995. The age range was 12 to 40 years. In both studies, the major contributor to sudden death from cardiovascular causes during sport was hypertrophic cardiomyopathy (HCM).

The second most common cardiovascular cause of death in the two studies mentioned previously was congenital abnormalities of the coronary arteries, 16% and 13% in each study. Hypertension (HT; BP > 140/90 mmHg) is an easily identifiable and powerful independent risk factor for CVD affecting one third of the population of the USA (4). Another one-quarter of the adult American population have pre-hypertension (PHT; BP 120-139/80-89 mmHg) (5,6). PHT is not a recognised condition in the UK, however, coronary heart disease (CHD) is the UK's biggest single killer: 114,000 people died in 2003, which is 3.5 times greater than deaths recorded from lung cancer (7). Medical examinations prior to athletic events are crucial if we are to identify individuals at risk from cardiovascular complications. The sport of amateur boxing requires contestants to have a routine medical examination, undertaken by a doctor, including BP and urinalysis, and the provision of a signed certificate prior to acceptance into a competition. This is performed in addition to a less stringent examination, on the day of the contest itself. In contrast, the sport of full contact Karate only requires the contestant to fill out a pre-exercise health screening document, which is a detailed questionnaire of personal and family medical history. The contestants then undergo a routine medical examination on the day of competition. Contact Karate is a high intensity activity, requiring severe exertion as well as direct blows to the chest wall. Chest wall impact could be responsible for sudden cardiac death, i.e. “commotio cordis” and evidence indicates that ventricular repolarization abnormalities were present in ECG traces recorded in 20 % of boxers, possibly due to sympathetic hyper-activity related to the agonistic event (8). We are concerned that chest wall impact which is considered to be dangerous to participants with known or undiagnosed HT, may predispose to heart-attacks or sudden death (9). It has been estimated in a study by Miura et al., (2001) that approximately 15% of blood-pressure related deaths from CHD occur in individuals with BP in the pre-hypertensive range and sudden death is often the first manifestation of CVD (10). In 2003, the 7th Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC 7) suggested that individuals with a systolic BP of 120 to 139 mmHg or a diastolic BP of 80-89 mmHg should be considered PHT. The committee also suggested that these individuals should receive advice on life-style management to prevent further progression to HT and CVD. Currently there is no regulation in force which forbids PHT or HT individuals from competing in full contact Karate (or other contact sports with the exception of boxing).We hypothesized that individuals may be competing in full contact karate tournaments with elevated blood pressures that may be misdiagnosed as white coat hypertension.
The aim of the present study was to assess BP in a cohort of contestants in a national karate competition (KC), and to compare the values obtained with a cohort of age-matched exercising controls (EC) of similar training status pre- and post-activity. A secondary aim was to draw attention to the possible anomalous situation, whereby individuals compete in karate tournaments with essential hypertension that may be masked by anxiety induced hypertension.

METHODS

Subjects
Prior to data collection all subjects read and completed an informed consent form, which outlined experimental procedures, data collection techniques and the purpose of the study. Ethical approval for the study was granted by the University ethics committee. A pre-competition medical examination on the morning of the event was conducted on all contestants who entered a National full contact Karate championship in England, 2004. Data collection procedures comprised of personal interviews and physical examinations. There were 43 apparently healthy KC participants, who had registered for the karate competition. None of the competitors or exercising controls had been previously diagnosed with hypertension. None had seen their own family doctor in the previous 12 month period. The 43 KC subjects comprised of 33 white Caucasian, 6 Chinese-descent and 4 black Asian-descent. 17 and 26 of the entrants were categorized as normotensive (NT) and high blood pressure (HBP), respectively (Table 1).

The 41 EC subjects were white Caucasian. All controls were of similar training status as the exercising group (brown and black belt grade karate practitioners) and all participated in karate training at regular intervals for a minimum period of three years, three times a week, for two hour periods. Training status, frequency and duration of training was obtained from a data base provided by the karate organization.

Procedures
EC subjects performed an exercise routine at maximum effort for 2 minutes duration (the duration of a fighting round) utilizing kicking and punching techniques mimicking those used in karate tournaments (devised in conjunction with competition video analysis and the karate coaches themselves). The exercise regime produced a corresponding heart rate increase in excess of 80% maximum for all subjects. Heart rate values were recorded using short range telemetry, both at rest, and post exercise (Sport Tester PE 3000, Polar Electro Finland). Maximum heart rates were calculated using the predictive formula of 220 bpm minus individual subject age. BP measurements were recorded in the control group under the same experimental conditions and in the same order as the karate competitors pre- and post-exercise.

Pre-exercise Measurement and Evaluation
Subject information included the self-reported demographic characteristics of; age, gender, race, medical history, drug history, smoking history, family history, dietary intake and physical activity. All subjects were non-smokers and were examined having avoided the ingestion of caffeine and exercise 12 hours prior to BP measurement. Physical activity was recorded as the number of training days per week and minutes per session for the previous 12 months. Data on nutritional information was provided using a 3-day dietary recall. Each subject recorded the quantity, type of food and beverage ingested for the previous 3-day period prior to the competition. This information was analysed using a computer software package (Comp-Eat, UK), for dietary calorie, protein, fat and carbohydrate intake. To our knowledge no individuals were taking ergogenic aids, which are banned within the sport, or more importantly with reference to this study, calming medication such as anxiolytics or beta-blockers.

Height was measured with a stadiometer (Cranlea Instruments, Cranlea and Co., Birmingham, UK) and weight was measured using a balanced weighing scale (Cranlea Instruments, Cranlea and Co.,
Birmingham, UK). Pre-competition examination consisted of a standardized medical examination of the cardio-respiratory and central nervous systems on the morning of the actual competition and the morning previous to the competition for both the KC and EC groups. BP measurements were obtained by a single physician at the beginning of the physical examination, using a calibrated mercury column sphygmomanometer (Yamasu, Kenzmedico Co., Ltd., Japan). BP was measured pre-competition from the bared arm, with the patient seated on a chair, with a back support, for five minutes with both feet on the floor and legs uncrossed. The arm was supported at heart level and the appropriate sized cuff was used, ensuring 80% of the circumference of the subject’s arm was encircled. The Korotkoff sounds were measured from the brachial artery in the antecubital fossa, using the diaphragm of the stethoscope (Littmann, 3M, Loughborough, England, UK).

BP pre-exercise, was ascertained from both arms and if the difference was less than 10 mmHg the reading was taken from the right arm. All readings that were finally used were measured from the right arm, since there were no differences between the right and left arm. Two auscultatory measurements in each position were made at an interval of one minute and an average of those readings was used to represent the patient’s BP. If these readings did not agree to within 5 mmHg for SBP and DBP a further two readings were made and the average of those multiple readings was used. Post-exercise the final distinct muffling of the repetitive sounds, Korotkoff phase 4 (K4) was taken as the diastolic pressure. Laboratory tests on day 1, consisted of a urinalysis with a Multistix®, (Bayer Co., USA) to eliminate diabetes mellitus or a possible renal cause for hypertension.

Exercise Measurements
Data: HR and BP were collected on all 84 subjects in the morning between the hours of 09:00 and 12:00, post-exercise at 1, 2 and 8 minute intervals. The readings were taken following procedures mentioned previously for pre-exercise measurements. This was done to obtain BP and HR at these time points. Post exercise BP measurements were taken in conjunction with electronic timing devices that were simultaneously started when the claxon signalled the end of the fighting bout for the competing subjects. This ensured accuracy and consistency of measurement for all subjects.

Statistical Analyses
Data were analysed using the SPSS 11.0 for Windows statistical package. Group differences were analysed using a two-way (group x time) repeated measures ANOVA. Between group differences were analysed using an independent t-test with an α level set at the \( P< 0.05 \) for significance. Within group differences were analysed using a paired t-test followed by a post-hoc Bonferroni α level set at \( P< 0.017 \) for significance. All t-test were two-tailed. All Data are presented as the mean ± standard error of the mean (SEM).

RESULTS
There were no protein or caloric intake differences between any groups. There was no difference between KC and EC on day 1, a total rest day, one day pre-competition. Nine percent of subjects in KC \( (n=4) \) had borderline hypertension \( \geq 140/90 \) mmHg on day 1. Pre-competition characteristics by SBP status at rest on the morning of competition (day 2), revealed that HBP subjects in the KC had a significantly greater SBP than NT subjects, stage 1 hypertension \( (150±3 \) vs. \( 129±1 \) mmHg, \( P< 0.05 \)) and there was a significant difference at rest on day 2 between KC and EC \( (P<0.05) \). Pre-competition characteristics by SBP status at rest on the morning of competition revealed that subjects in EC had a clinically elevated SBP compared with NT subjects, stage 1 hypertension \( (142±1 \) vs. \( 123±1 \) mmHg). At 8 minutes post-competition, SBP status revealed that HBP
Table 1: Cardiovascular Parameters on rest day, one day pre-competition (Day 1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Karate Group (n=43)</th>
<th>Control Group (n=41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>30.1 ± 1.3</td>
<td>31.2 ± 1.4</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.74 ± 0.01</td>
<td>1.73 ± 0.01</td>
</tr>
<tr>
<td>BM (kg)</td>
<td>78.9 ± 1.9</td>
<td>79.1 ± 2.1</td>
</tr>
<tr>
<td>BMI (kg.m⁻²)</td>
<td>26.1 ± 0.6</td>
<td>26.3 ± 0.7</td>
</tr>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>134±3</td>
<td>124±1</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>84 ± 2</td>
<td>80 ± 2</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>79 ± 2</td>
<td>75 ± 2</td>
</tr>
<tr>
<td>RPP</td>
<td>100±4</td>
<td>98</td>
</tr>
<tr>
<td>Normal Values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>RPP</td>
<td>86</td>
<td>88</td>
</tr>
<tr>
<td>Hypertensive Values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>RPP</td>
<td>98</td>
<td>98</td>
</tr>
</tbody>
</table>

SBP, Systolic blood pressure (mmHg); DBP, Diastolic blood pressure (mm.Hg); HR, Heart Rate (beats per minute); RPP, Rate Pressure Product (SBP X HR x 10⁻²); Figures are presented as means ± Standard Deviation (SD); * = P<0.05 = Significantly different from EC.

Subjects in the KC (n=4) had an SBP significantly greater than NT subjects (n=39), stage 1 hypertension (152±2 vs. 127±2 mmHg, P< 0.05).

HBP AND NT, both KC and EC, showed a statistically significant increase from baseline and normal physiological response to exercise, at peak 1 minute and 2 minutes post exercise. There were no statistical differences between the groups. Sixty percent (n=26) of the karate cohort participants and 5% of the EC group (n=2) had an elevated BP (HBP) recorded on the day of competition, but 8 minutes post-exercise only 9% and 5% respectively, were elevated and advised to seek further evaluation.

**DISCUSSION**

Psychological stimuli, such as pre-competition stress (11) is an accepted stimulus influencing cardiovascular reactivity (12) stimulating the sympathetic nervous system and inducing changes which may affect long-term blood pressure regulation. Such individuals with elevated blood pressure, once identified, should ideally have other CVD risk factors evaluated in an appropriate clinical environment (13). In this study SBP and DBP were elevated in 54% and 16% respectively, pre-competition (which would be classified as stage 1 hypertension). This may reflect the incipient mental stress of competition and the fear factor inherent prior to a full contact karate bout. Research has suggested that a stressful situation may have been compounded by the medical examination on the morning of the competition, rather than the day before, potentially leading to these anxiety induced hypertensive levels and could be mislabeled as “white-coat hypertension” (14,15). In this study there was a significant difference observed in resting BP measurements one day prior to competition versus the day of competition in the KC group (P<0.05) and a significant difference at rest on day 2 between KC and EC (P<0.05). The commonly used definition of white-coat hypertension is a persistently elevated average office BP but an average awake ambulatory reading of <135/85 mmHg. This phenomenon can occur at any age (16). The RPP (rate pressure product) at rest in HBP in KC was significantly higher than NT in KC and EC (118 ± 5 vs. 96 ± 3 vs. 86 ± 3) and was above the normal level (Tables 1 & 2) There were no differences between Karate Competitors (KC) and Exercise Controls (EC), on day 1 (pre-competition). This changed on day 2 (competition day), where a significant difference in BP, between KC and EC was observed at rest.
Psychological factors are one of a number of causes of elevated BP but one cannot rule out the classic “white coat hypertension”. Whatever the cause, several individuals were identified as having antihypertensive medication. No interventive lifestyle changes were advised to the EC subjects.

The subjects with HBP, recorded on the day of the competition, 8 minutes post-exercise, were referred to their own doctors. Medical follow up in these individuals identified that 9% \((n=4)\) of the karate cohort subjects commenced lifestyle changes and 5% \((n=2)\) were commenced on antihypertensive medication. No interventive lifestyle changes were advised to the EC subjects.

**CONCLUSIONS**

Psychological factors are one of a number of causes of elevated BP but one cannot rule out the classic “white coat hypertension”. Whatever the cause, several individuals were identified as having

<table>
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<th>Variable</th>
<th>Karate Group ((n=43))</th>
<th>Exercise Control Group ((n=41))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 2</strong></td>
<td>SBP DBP HR RPP</td>
<td>SBP DBP HR RPP</td>
</tr>
<tr>
<td>Total Rest ((n=26))</td>
<td>141 ± 3 79 ± 2 77 ± 2 109 ± 3</td>
<td>125±1*† 71 ± 2 72 ± 2 90 ± 3*</td>
</tr>
<tr>
<td>HBP @ Rest ((n=26))</td>
<td>150 ± 3 82 ± 2 79 ± 2 118 ± 5</td>
<td>142±1 79 ± 1 77 ± 1 109 ± 1</td>
</tr>
<tr>
<td>HBP 1 min post ((n=26))</td>
<td>211 ± 2 79 ± 1 180 ± 2 380 ± 6</td>
<td>208±1 77 ± 1 175 ± 1 364 ± 1</td>
</tr>
<tr>
<td>HBP 2 min post ((n=26))</td>
<td>167 ± 5 55 ± 1 130 ± 4 224 ± 16</td>
<td>161±1 65 ± 1 125 ± 1 201 ± 1</td>
</tr>
<tr>
<td>HBP 8 min post ((n=4))</td>
<td>152 ± 2 81 ± 1 85 ± 2 129 ± 3</td>
<td>147±2 78 ± 1 83 ± 1 122 ± 1</td>
</tr>
<tr>
<td>NT @ Rest ((n=17))</td>
<td>129±2* 74 ± 2 74 ± 2 96 ± 3*</td>
<td>123±1* 68 ± 2 70 ± 2 86 ± 3*</td>
</tr>
<tr>
<td>NT 1 min post ((n=17))</td>
<td>202 ± 2 74 ± 1* 186 ± 3 375 ± 8</td>
<td>199±2 72 ± 2* 189 ± 3 376 ± 7</td>
</tr>
<tr>
<td>NT 2 min post ((n=17))</td>
<td>160 ± 5 51 ± 2 124 ± 5 221 ± 14</td>
<td>156±5 67 ± 2 121 ± 5 189±14</td>
</tr>
<tr>
<td>NT 8 min post ((n=39))</td>
<td>127±2* 73 ± 1 75 ± 2 95 ± 3*</td>
<td>122±2* 72 ± 1 73 ± 2 89 ± 3*</td>
</tr>
</tbody>
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SBP, Systolic blood pressure (mmHg); DBP, Diastolic blood pressure (mm.Hg); HR, Heart Rate (beats per minute); RPP, Rate Pressure Product (SBP X HR x 10²); Figures are presented as means ± Standard error of the mean (SEM) * = \(P<0.05\) = Significantly different from HBP; † = \(P<0.05\) = Significantly different from KC

The inability to supply oxygen to the myocardium when demand is high appears to be related to several cardiovascular events, including transient myocardial ischemia, acute myocardial infarction, and sudden death (3). Myocardial oxygen consumption is correlated with the RPP and this hemodynamic parameter has been shown to follow a circadian pattern similar to that observed with cardiovascular events (17). Epidemiologic data have also demonstrated a positive relationship between elevated resting heart rate and increased mortality, but there was no evidence of this on day 1. In a meta-analysis of several relevant studies, Palatini and Julius (1997) (18) confirmed this association and also noted that individuals with elevated heart rates were more likely to develop hypertension than subjects with low heart rates. Laukkanen et al., (2004) (19) showed that men with elevated SBP > 195 mmHg, 2 minutes post exercise had a 1.69-fold risk for an acute myocardial infarction (MI) compared with those with SBP < 170 mmHg after adjustment for age, other risk factors and resting SBP. This emphasized the importance of SBP measurements post-exercise providing valuable prognostic measures with regard to MI. All groups, two minutes post exercise had SBP <170 mmHg. The data obtained in this study would tend to support a mechanism of elevated BP other than CVD.

The subjects with HBP, recorded on the day of the competition, 8 minutes post-exercise, were referred to their own doctors. Medical follow up in these individuals identified that 9% \((n=4)\) of the karate cohort subjects commenced lifestyle changes and 5% \((n=2)\) were commenced on antihypertensive medication. No interventive lifestyle changes were advised to the EC subjects.
borderline hypertension, at rest, one day pre-competition and required subsequent assessment and 
interventive therapy. This suggests that there is a need to exclude any abnormal autonomic-cardiac 
regulation as seen in sustained hypertensive states during activities that require high intensity 
exercise levels. The findings of this study indicate that anxiety induced hypertension can mask 
essential hypertension in karate activities. Medical practitioners need to be aware of this finding when 
conducting medical examinations prior to high intensity recreational activities.

**Address for correspondence:** Baker JS, PhD, Health and Exercise Science Research Laboratory, 
School of Applied Science, University of Glamorgan, Pontypridd, Wales, UK, CF37 1DL. Phone 
(+4401443482972); FAX: (+4401443482285); Email. jsbaker@glam.ac.uk

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