

COLD PRESSOR TEST ON ATOMIC BOMB SURVIVORS

原爆被爆生存者における寒冷昇圧試験

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## COLD PRESSOR TEST ON ATOMIC BOMB SURVIVORS - NAGASAKI

原爆被爆生存者における寒冷昇圧試験 - 長崎

### INTRODUCTION

It has been noted in various types of animal experiments that as a biological effect of irradiation, shortening of life span occurs with the absence of specific causes of death.<sup>1-5</sup> Warren's study<sup>6</sup> of the ages at death of radiologists suggested that life span possibly might be shortened by irradiation. Possible shortening of life span as a late somatic effect in the atomic bomb survivors of Hiroshima and Nagasaki cities is being extensively studied in a joint program by the Atomic Bomb Casualty Commission (ABCC) and the Japanese National Institute of Health (JNIH).<sup>7</sup>

As part of this program specific follow-up studies<sup>8,9</sup> are being made for detecting any early senile changes in the various organs and systems, and close observations will continue in the future. Particularly, since the senile changes which primarily determine the life span take place in the circulatory system, study of the process of degeneration or changes in the phase of the physiological function in this field is very important.

The cold pressor test which was originated by Hines and Brown<sup>10</sup> in 1933 is a simple laboratory test to study the irritability and reactivity of the peripheral arteriole. Subsequently, the test has been applied in laboratory studies primarily to detect functional disturbances of peripheral blood vessels in essential hypertension and latent hypertension.<sup>11-17</sup>

Although the response is influenced by various biological and environmental factors, no detailed statistical report which gives consideration to these factors has been made. Hence, the present study attempts first to consider the factors which it is felt may affect this response and then to elucidate a phase of the functional change occurring in the cardiovascular system of the A-bomb survivors.

### 緒言

諸種動物実験における放射線照射の生物学的影響として、特定の死因なくして起こる寿命の短縮が認められている。<sup>1-5</sup> Warren<sup>6</sup>は放射線医の死亡年齢を調査し、放射線照射に起因して寿命が短縮する可能性を示唆した。広島、長崎両市の被爆生存者の身体的後影響の1つとしての寿命短縮に関する問題は、目下原爆傷害調査委員会 (ABCC) と国立予防衛生研究所 (予研) の共同で大々的な調査<sup>7</sup> が進められている。

この調査の一部として各種器管系統の早期老向変化を追求<sup>8,9</sup> するために特定の継続調査がなされており、緻密な観察が今後も進められるであろう。なかでも、寿命を決定するおもな老向変化は循環器系にあり、加齢に伴うこの領域の変性過程、あるいは生理的機能面の変化を調べることは、はなはだ重要である。

寒冷昇圧試験は、末梢細動脈の被刺激性もしくは反応性を調べる簡単な臨床検査法で、1933年に Hines および Brown<sup>10</sup> によって創始された。その後本態性高血圧症もしくは潜在性高血圧症における末梢血管の機能異常の検出を主目的として臨床面で応用されている。<sup>11-17</sup>

本反応は種々の生物学的・環境的要因により影響されるが、従来これらの要因を考慮した統計学的に詳細な報告はみられない。そこでまず本反応に影響すると思われる要因について検討を加え、ついで被爆生存者における心血管系機能変化の一面を検出する目的で本調査を試みた。

## SAMPLE

The study included 1156 healthy men and women of the ABCC-JNIH Adult Health Study sample<sup>18</sup> whose ages ranged from 15 to 81 years and had undergone routine physical examination at ABCC, Nagasaki, during June-October 1960. The sample was comprised of four comparison groups:

Group 1 305 persons located within 2000 m from the hypocenter at the time of the bomb (ATB); reported acute symptoms of irradiation.

Group 2 303 persons located within 2000 m from the hypocenter; reported no acute symptoms of irradiation.

Group 3 287 persons located at 3000-3999 m from the hypocenter.

Group 4 261 persons located beyond 10,000 m or not present in the city ATB.

Of these, Groups 3 and 4 may be regarded as control groups in relation to irradiation.<sup>19</sup> All four groups are so arranged as to have practically identical composition by sex, age and month of examination (Tables 5-8).

## METHOD

The examinees were asked to rest in supine position for approximately 20 minutes in a room maintained at 25-30°C. After ascertaining that pulse and blood pressure had become stable, blood pressure reading was taken on the right upper arm. Next, the left hand was immersed to just above the wrist in ice water of 3-5°C for one minute. Reading of blood pressure was taken at the end of 30 seconds and 60 seconds, and the maximal difference between the blood pressure before and after cold stimulus was regarded as the response value. Anyone whose systolic or diastolic pressure response values exceeded 20 mmHg or 15 mmHg respectively was defined as a hyperreactor.

## RESULTS

### Factors Affecting the Cold Pressor Test Values

The mean values of blood pressure response to cold stimulus in the 1156 subjects tested were 13.8 mmHg systolic pressure and 12.5 mmHg diastolic pressure, and the frequency of hyperreactor was 25.1% in systolic

## 標本

ABCC - 予研成人健康調査標本<sup>18</sup>のうち1960年6月から10月まで長崎ABCCにおいて一般健康診断を受けた15歳から81歳までの健康男女1156人を対象とした。これらの対象は4つの比較群で構成されている。

第1群 原爆時に爆心地から2000m以内の距離にいて急性放射線症候を呈したものの305人。

第2群 爆心地から2000m以内の距離にいて急性放射線症候を呈さなかったものの303人。

第3群 爆心地から3000 - 3999mの距離にいたもの287人。

第4群 原爆時10,000m以遠にいたものあるいは市内にいなかったもの261人。

このうち第3群と第4群は放射線照射に関して対象群とみなすことができる。<sup>19</sup> これら4つの群は性、年齢、検査月別構成がほとんど同一に保たれるようにできている(表5-8)。

## 方法

被検者に室温25 - 30°Cで約20分間安静仰臥位をとらせ、脈搏、血圧の安定したことを確かめたのち、右上腕にて血圧を測定し、ついで左手首を関節の直上まで3 - 5°Cの氷水中に1分間浸す。その間30秒後および60秒後に血圧を測定し、寒冷刺激前の血圧と刺激後の血圧の最大差を反応値とした。収縮期圧20 mmHg以上、拡張期圧15 mmHg以上の反応を示すものをhyperreactorと定めた。

## 成績

### 寒冷昇圧値に及ぼす要因

被検者1156人の寒冷刺激に対する血圧の反応平均値は、収縮期圧で13.8 mmHg、拡張期圧では12.5 mmHg、hyperreactor 頻度は収縮期圧で25.1%、拡張期圧では



pressure and 35.8% in diastolic pressure (Tables 1 and 2). The response in systolic pressure increased with age. The mean response value of 16.8 mmHg and hyperreactor frequency of 35.4% in the group over 40 years of age was exceedingly high as compared with the mean response value of 11.9 mmHg and hyperreactor frequency of 18.9% in the group under 40 years. In diastolic pressure, no difference of response by age was observed (Tables 1 and 2). Increased response was noted with elevated systolic pressure in the aged, and a fairly high response was noted in the young with systolic pressure 150 mmHg or over, which is considered to be hypertension (Table 2). Further, the mean response value of 17.8 mmHg and hyperreactor frequency of 39.4% in subjects with systolic pressure 140 mmHg or over, was much higher than the 12.9 mmHg and 21.3% observed for subjects with systolic blood pressure below 140 mmHg (Table 4). The diastolic pressure, in contrast, showed decreased response with increased blood pressure (Table 2). That is, the mean response value of 11.2 mmHg and the hyperreactor frequency of 30.3% in subjects with diastolic pressure 80 mmHg or over, was lower than the 13.1 mmHg and 38.5% for subjects with diastolic pressure below 80 mmHg (Table 4).

By sex, the mean response value of 14.9 mmHg and hyperreactor frequency of 27.7% in systolic blood pressure in the 491 males was somewhat higher than the 12.3 mmHg and 23.2% observed for the 665 females. In diastolic blood pressure also, the mean response value of 13.6 mmHg and the hyperreactor frequency of 41.3% in the males was higher than the 11.6 mmHg and 31.7% observed for the females (Table 4).

Although the composition of the sample as to sex, age and blood pressure was the same for all months of examination, response was noted to differ remarkably by the month of examination (Table 3). Higher response was noted for both systolic and diastolic blood pressures during the summer months (June, July and August) than during the autumn months (September and October). In particular, the response was marked in the aged in July when atmospheric temperature reaches the peak.

The results are summarized as follows:

**Age.** Systolic pressure but not diastolic pressure showed increased response with age.

**Month of Examination.** Both systolic and diastolic pressures showed greater response during the summer months than during the autumn months.

35.8%であった(表1, 2)。収縮期圧の反応は加齢とともに上昇がみられ、40歳以上の高年者の反応平均値16.8 mmHg, hyperreactor 頻度35.4%は40歳以下の若年者の反応平均値11.9 mmHg, hyperreactor 頻度18.9%に比べて著しく高い反応である。拡張期圧については反応の年齢的差異は認められない(表1, 2)。高年者では収縮期圧の上昇とともに反応の増大を示し、若年者では高血圧と思われる収縮期圧150 mmHg以上のものになりに高い反応がみられた(表2)。また収縮期圧140 mmHg以上の対象者の反応平均値17.8 mmHg, hyperreactor 頻度39.4%は、収縮期圧140 mmHg以下の対象者の反応平均値12.9 mmHg, hyperreactor 頻度21.3%に比べて明らかに高い反応を示すものである(表4)。一方、拡張期圧における反応では、拡張期圧の上昇とは逆に反応の低下がみられる(表2)。すなわち、拡張期圧80 mmHg以上の対象者の反応平均値11.2 mmHg, hyperreactor 頻度30.3%は、拡張期圧80 mmHg以下の対象者の反応平均値13.1 mmHg, hyperreactor 頻度38.5%に比べて低い反応である(表4)。

各調査月の性、年齢、血圧構成は同一であったにもかかわらず、反応は調査月により著しく異なった(表3)。夏期(6, 7, 8月)は秋期(9, 10月)より収縮期、拡張期圧ともに高い反応がみられ、特に高年者では気温の最も高い7月に著しい反応が現われた。

性別では男性491名の収縮期圧の反応平均値14.9 mmHg, hyperreactor 頻度27.7%は、女性665名の反応平均値12.3 mmHg, hyperreactor 頻度23.2%に比し若干高い値を示し、拡張期圧における反応でも男性の反応平均値13.6 mmHg, hyperreactor 頻度41.3%は、女性の反応平均値11.6 mmHg, hyperreactor 頻度31.7%に比して高い反応がみられた(表4)。

結果を要約すると次のとおりである。

**年齢。**収縮期圧の反応は加齢とともに増大したが拡張期圧では加齢による変化は認められない。

**調査月。**夏期では秋期に比べて収縮期圧、拡張期圧ともに反応の増大が認められる。



**Blood Pressure.** While systolic pressure showed increased response with elevated blood pressure, diastolic pressure, on the contrary, showed decreased response.

**Sex.** Both systolic and diastolic pressures showed a somewhat higher response in males than in females.

#### Relation to Irradiation

No statistically significant difference in response was noted between the four Comparison Groups (Table 5). However, the cold pressor test response is considerably affected by various factors which could have been operative among Comparison Groups. Hence, further analysis was made in which age, sex and month of examination were considered in regard to the response in systolic pressure, and sex, month of examination and diastolic pressure were considered in regard to the response in diastolic pressure.

#### Response in Systolic Blood Pressure

In comparisons by month of examination, the young and aged showed no difference in response between Comparison Groups (Table 5). However, by sex, a difference in response was observed for young males (Table 6). Since the response in young males was high in Comparison Group 4 and low in Comparison Group 3, a difference occurred in the mean response value, which was significant at the level of 5% or less, and in the hyperreactor frequency, which was suggestive at the level of 10% or less. However, these differences can not be considered as related to effects of irradiation from the atomic bomb. Subjects in Comparison Group 3 were located beyond the range at which any effect might be expected, as were those in Comparison Group 4, and the two groups show different response values which are at both extremes. Further, young females do not show any such tendency. Thus, the cause of this difference must be sought elsewhere.

#### Response in Diastolic Blood Pressure

In comparison by month of examination, the mean response values in both sexes classified by diastolic pressure above and below 80 mmHg showed no difference among Comparison Groups (Table 7). A high frequency of hyperreactor, significant at the 0.1% level, was noted among Comparison Groups 3 and 4 during the summer months in both sexes for diastolic pressure below 80 mmHg (Tables 7, 8). However, this difference cannot be related to an irradiation effect, because no statistically significant difference was noted in mean response values among the Comparison Groups, and also, the hyperreactor frequency

血圧。収縮期圧が高いほどその反応は増大するが、拡張期圧では逆に反応は減少する。

性。男性は女性より収縮期、拡張期圧ともにいくぶん高い反応を示す。

#### 放射線照射との関係

4つの比較群間には反応の差異は統計上認められない(表5)。しかし寒冷昇圧値は種々の要因によりその反応をかなり異にし、各比較群間でも作用しあっているといえる。そこで収縮期圧の反応については年齢、性、調査月を、拡張期圧の反応については性、調査月、拡張期圧を考慮比較することにした。

#### 収縮期圧における反応

調査月別では若年者も高齢者も比較群間に反応差は認められない(表5)。しかし男女別にみると男性若年者へのみ反応差がみられた(表6)。男性若年者における反応値が第4群において高く、第3群で低いため平均反応値では5%以下のレベルで有意差を、hyperreactor 頻度では10%以下のレベルで suggestive な差異を得た。しかしこの差は被曝効果によるものとは考え難い。第3群の対象者は第4群と同様何らかの影響が期待される区域の外にいたと考えられ、両者の間で群間反応差の両極をなしている。また女性若年者では群間のこのような傾向すら認められないことなど、その差異の原因を他に求めねばならない。

#### 拡張期圧における反応

調査月別では拡張期圧80 mmHg以下とそれ以上の男女における反応平均値の比較群間の差異は認められない(表7)。Hyperreactor 頻度では第3群および第4群が高く、夏期の拡張期圧80 mmHg以下の男女にのみ0.1%のレベルで群間差異がみられる(表7, 8)。しかしこの差異を直ちに被曝効果と結びつけることはできない。なぜなら反応平均値に関する限り統計上の有意差が群間に認められなかったこと、また夏期・秋期における拡張期圧

in both sexes with diastolic pressure 80 mmHg or over was not notably high in Comparison Groups 3 and 4 during the summer and autumn months.

## DISCUSSION

When the skin is exposed to a considerably large dose of radiation for therapeutical purposes the capillary blood vessels undergo a morphological change a half year to several years later,<sup>20</sup> but the other organs of the cardiovascular system are generally considered to be radio-resistant.<sup>21-23</sup> Few survivors of the atomic bomb experienced such large doses, but if it be assumed that some change eventually would occur to the peripheral arteriole, which is the primary blood pressure regulating organ, the smaller the dose the longer the latent period and, probably, the milder the functional or organic change would be. Hines<sup>16</sup> reported that hyperreactors on cold pressor tests performed to detect abnormal excitability of the peripheral blood vessels are very likely to develop essential hypertension later in life, and applied this test in the diagnosis of prehypertensive state. That is, the objective was to detect latent functional abnormalities in the blood vessels from variation of blood pressure under cold stimulus. This is in accord with the purpose of the present study, which attempts to detect in the early stage any latent functional changes in the peripheral blood vessels which might have been caused by irradiation. The elevation of blood pressure by this test is ascribed to the mechanism of the nerve or body fluid,<sup>24,25</sup> and generally when the increase in systolic pressure exceeds 20 mmHg or increase in diastolic pressure exceeds 15 mmHg, the response is regarded as hyperreactive and the peripheral arteriole is considered to be in an abnormally excited state.<sup>16</sup> It is commonly known that a high rate of hyperreaction is seen in those who have essential hypertension and abnormal neurocirculatory tonus. Accelerated excitability due to senile change of the arteriole is believed to be one of the reasons for the high rate of hyperreactor noted in the aged including those who were normotensive.

The difference in response by the month of examination, particularly the increased response noted in July and August, probably is caused primarily by the increased cold stimulus due to the relative difference between the cold water temperature and the high room temperature and by the sudden contraction of the dilated peripheral blood vessels.<sup>13</sup>

The response of systolic pressure reflected the change with age quite well, but no meaningful differences were seen between Comparison Groups. The response of diastolic pressure showed no change with age and the

80 mmHg以上の男女の hyperreactor 頻度は第3および第4群に必ずしも高くないことである。

## 考案

放射線治療の目的で皮膚に相当量の線量が照射された場合、半年ないし数年後に毛細血管に形態的变化の起こることが知られているが、<sup>20</sup> 他の部分の心血管系は一般に放射線抵抗のある器官と考えられている。<sup>21-23</sup> 被爆生存者でこのような大線量を照射された例は少ないが、血圧調節の主役である末梢細動脈に早晚何か変化を起こすものと想定すれば、被爆時線量が小さいほど変化の発現までに長い潜伏期を経て、程度の軽い機能的もしくは機質的变化が起こるかもしれない。Hines<sup>16</sup> は末梢血管の異常興奮性の検出に寒冷昇圧試験を行ない、hyperreactor を示すものは将来本態性高血圧症に移行する可能性の大きいことを述べ、前高血圧状態の診断に本テストを応用した。すなわち、寒冷負荷による血圧の変動から、血管の潜在的機能異常の検出をねらったものであり、このことは放射線照射に基づく末梢血管の潜在的な機能変化の早期検出を試みた本研究の目的と合致する。本テストでの昇圧は神経性もしくは体液性機序によるものと解せられており、<sup>24,25</sup> 一般に収縮期圧で20 mmHg以上、拡張期圧で15 mmHg以上の昇圧は hyperreactive とされ、末梢細動脈が異常興奮状態にあるとされている。<sup>16</sup> 従来本態性高血圧症・自律神経緊張異常者に hyperreaction が高率にみられることは周知のことである。本研究で正常血圧の高年者に hyperreactor の高率であったことは、1つに細動脈の老向性変化に基づく興奮性の亢進によるものと思われる。

調査月別による反応の差異、ことに7、8月に反応の増大を認めたことは、冷水と室温の相対温度差による冷刺激の増強と、弛緩した末梢血管の急激な収縮が主因であろう。<sup>13</sup>

収縮期圧の反応は加齢による変化をよく反映したが、比較群間に有意な差異はみられなかった。拡張期圧では加齢による反応の変化はみられず、反応平均値では比較

mean response value in diastolic pressure showed no difference between Comparison Groups. However, the frequency of hyperreactor did show a difference, the response being particularly remarkable in females during the summer months. Difference in response between Comparison Groups was also apparent during the summer months in both sexes with diastolic pressure below 80 mmHg. However, males showed no difference in response between Comparison Groups during both the summer and autumn months, and females also showed no difference in response between Comparison Groups during the autumn months. No difference in response between Comparison Groups was noted in either sex with diastolic blood pressure below 80 mmHg or with diastolic blood pressure 80 mmHg or over during the summer and autumn months.

In view of the results the difference in hyperreactor frequency between Comparison Groups can not be attributed to an effect of radiation exposure. To elucidate the cause, difference in the time of study, the number of subjects of study, the sampling method, etc., and other biological and environmental factors should be reviewed. To relate any abnormality of physiological function to irradiation, the milder the degree of abnormality, the more necessary it becomes to study a larger sample under similar biological and environmental conditions.

The cold pressor test has such advantages as being very simple to perform, causing minimal unpleasantness to the examinees, and being easy to perform on a large sample. On the other hand, the response values derived from the test are influenced by many factors such as sex, age, blood pressure, physical constitution and environment, and a fairly large sample is required for the statistical evaluation of radiation effects. If further study is made, it would be desirable to select the summer months when the response values are great, and also, to employ a large sample in which factors affecting the cold pressor test values are reduced to the minimum.

## SUMMARY AND CONCLUSION

Cold pressor test was performed on a sample of 1156 atomic bomb survivors and other persons (ages ranging between 15-81 years) residing in Nagasaki City. Response values differed according to such factors as age, sex, blood pressure and month of examination. The response in systolic pressure increased with age but no evidence was found to support an acceleration of aging by irradiation. The response in diastolic blood pressure showed no change with age, but differed between Comparison Groups during the summer months. However, this was apparently due to some other cause than exposure to the atomic bomb.

群間に差異はみられなかった。しかし hyperreactor 頻度では夏期に群間反応差がみられ、とりわけ夏期の女性に反応差が現われたほか、夏期拡張期圧80 mmHg以下の男女にも同様の群間反応差がみられた。しかし男性では夏期・秋期とも群間反応差はみられず、秋期女性にも群間反応差はみられなかった。拡張期圧80 mmHg以下の男女、夏期・秋期の拡張期圧80 mmHg以上の男女にいずれも群間反応差はみられなかった。

この結果からみて hyperreactor 頻度の群間差異が放射線照射の影響によるとは考えられない。原因を究明するには調査時期、調査対象の数、抽出方法などの違い、その他生物学的・環境的要因を含めた検討を行なわねばならない。放射線照射と生理的機能変調の関係を検出するためには、変調の度合が軽微であるほど生物学的・環境的条件を同じくしたさらに大きい標本について調査する必要がある。

寒冷昇圧試験は実施がはなはだ簡単であり、かつ被検者への不快も少なく多くの対象者に容易に行なえる利点をもつ反面、その反応値は性、年齢、血圧、体質、環境など多くの要因に影響され、放射線照射の統計的評価にはかなり大きな標本を必要とする。もし今後同様の調査が行なわれるとすれば、反応値の大きい夏期を選び、寒冷昇圧値に及ぼす要因を少なくした大きい標本を用いることが望ましい。

## 要 約

長崎市在住の被爆生存者およびその他の1156名の対象者(15-81歳)について寒冷昇圧試験を行ない、反応値が年齢、性、血圧、調査月などの要因に従って異なることを認識した。収縮期圧の反応に加齢による増大を認めしたが、放射線照射による加齢促進を支持する証拠は認められなかった。拡張期圧の反応では加齢による変化はみられなかったが、夏期の反応で比較群間に反応差が認められた。しかしこれは原爆被爆による影響というよりは他の要因に基づくものと思われた。

TABLE 1 BLOOD PRESSURE RESPONSE TO STANDARD COLD STIMULUS, MEAN VALUE AND RATE OF HYPERREACTOR, BY AGE

表1 標準寒冷刺激に対する血圧反応の平均値と HYPERREACTOR 率: 年齢別

Prestimulus blood pressure 刺激前の血圧		Age 年齢								Total 計	
		15-29		30-39		40-49		50-81			
<b>Mean value of response mmHg* 反応の平均値</b>		No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均
Systolic 収縮期	<119	153	10.7	259	13.6	72	14.5	50	16.4	534	13.1
	120-139	117	9.8	147	11.1	74	13.8	76	18.6	414	12.6
	>140	12	12.4	33	15.9	31	19.5	132	18.3	208	17.8
	Total 計	282	10.4	439	12.9	177	15.1	258	18.0	1,156	13.8
Diastolic 拡張期	<79	235	13.4	342	12.9	107	12.9	96	13.4	780	13.1
	>80	47	9.7	97	9.2	70	11.9	162	12.6	376	11.2
	Total 計	282	12.8	439	12.1	177	12.5	258	12.9	1,156	12.5
<b>Hyperreactor rate** 率</b>											
Systolic 収縮期	<119	20	13.8 %	63	24.3 %	18	25.0 %	15	30.0 %	116	21.7 %
	120-139	14	11.9	27	18.4	22	29.7	29	38.1	92	22.2
	>140	2	22.4	10	33.3	15	48.3	55	41.6	82	39.4
	Total 計	36	12.8	100	22.8	55	31.1	99	38.4	290	25.1
Diastolic 拡張期	<79	88	37.4	132	38.6	44	41.1	36	37.5	300	38.5
	>80	10	21.3	26	26.8	20	28.6	58	35.8	114	30.0
	Total 計	98	34.8	158	36.0*	64	36.2	94	36.4	414	35.8

\*Difference between pre- and post-stimulus pressures. 刺激前と刺激後の反応値の差.

\*\*Pressure response: Systolic > 20 mmHg, Diastolic > 15 mmHg. 収縮期圧反応 20 mmHg 以上, 拡張期圧反応 15 mmHg 以上.

TABLE 2 BLOOD PRESSURE RESPONSE TO STANDARD COLD STIMULUS, MEAN VALUE AND RATE OF HYPERREACTOR, BY AGE

表2 標準寒冷刺激に対する血圧反応の平均値と HYPERREACTOR 率: 年齢別

Prestimulus blood pressure 刺激前の血圧		Age 年齢				Total 計	
		15-39		40-81			
<b>Mean value of response mmHg 反応の平均値</b>		No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均
Systolic 収縮期	<109	169	12.2	40	15.0	209	12.8
	110-119	243	12.7	82	15.4	325	13.4
	120-129	183	9.7	73	15.6	256	11.4
	130-139	81	12.4	77	16.8	158	14.6
	140-149	28	12.9	49	18.3	77	16.4
	>150	17	18.5	114	18.6	131	18.6
Total 計	721	11.9	435	16.8	1156	13.8	
Diastolic 拡張期	<59	88	17.4	9	19.3	97	17.6
	60-69	235	13.5	54	13.4	289	13.5
	70-79	254	11.2	140	12.7	394	11.7
	80-89	110	9.6	128	12.9	238	11.4
	>90	34	8.6	104	11.8	138	11.0
Total 計	721	12.3	435	12.7	1156	12.5	

TABLE 表2 Continued 続き

Prestimulus blood pressure 刺激前の血圧		Age 年齢				Total 計	
		15-39		40-81			
<b>Hyperreactor rate 率</b>							
Systolic 収縮期	<109	33	19.5 %	9	22.5 %	42	20.1 %
	110-119	50	20.5	23	29.2	74	22.8
	120-129	23	12.5	21	28.7	44	17.2
	130-139	18	28.5	30	38.9	48	30.4
	140-149	6	21.4	21	42.8	27	35.1
	>150	6	35.2	49	42.9	55	42.0
Total 計		136	18.8	154	35.6	290	25.1
Diastolic 拡張期	<59	52	59.1	4	44.4	56	57.7
	60-69	92	39.1	23	42.6	115	39.8
	70-79	76	29.9	53	37.9	129	32.7
	80-89	28	25.5	41	32.0	69	29.0
	>90	8	23.5	37	35.6	45	32.6
Total 計		256	35.5	158	36.3	414	35.8

TABLE 3 BLOOD PRESSURE RESPONSE TO STANDARD COLD STIMULUS, MEAN VALUE AND RATE OF HYPERREACTOR, BY AGE AND MONTH OF EXAMINATION

表3 標準寒冷刺激に対する血圧反応の平均値と HYPERREACTOR 率: 年齢・調査月別

Age 年齢	Month of examination 調査月										Total 計	
	June 6月		July 7月		August 8月		September 9月		October 10月			
<b>Mean value of response mmHg 反応の平均値</b>												
	No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均	No. 数	Mean 平均
15-39	130	12.0	128	13.9	143	13.3	157	11.3	163	9.9	721	11.9
40-81	83	19.1	74	20.0	91	15.9	84	16.9	103	13.3	435	16.8
Total 計	213	14.8	202	16.1	234	14.3	241	13.2	266	11.2	1156	13.8
15-39	130	10.9	128	14.0	143	14.7	157	11.9	163	10.5	721	12.3
40-81	83	13.1	74	15.3	91	13.9	84	12.7	103	9.6	435	12.7
Total 計	213	11.8	202	14.5	234	14.4	241	12.2	266	10.2	1156	12.5
<b>Hyperreactor rate 率</b>												
15-39	26	20.0 %	32	25.0 %	32	22.4 %	24	15.3 %	22	13.5 %	136	18.9 %
40-81	34	41.0	36	48.6	35	38.5	25	29.8	24	23.3	154	35.4
Total 計	60	28.0	68	33.6	67	28.6	49	20.3	46	17.2	290	25.1
15-39	39	30.0	57	44.5	66	46.2	49	31.2	45	27.6	256	35.5
40-81	33	39.8	37	50.0	37	40.7	30	35.7	21	20.4	158	36.3
Total 計	72	33.8	94	46.5	103	44.0	79	32.8	66	24.8	414	35.8

TABLE 4 SIGNIFICANCE TESTS, RESPONSE VALUE AND RATE OF HYPERREACTOR ON AGE, SEX MONTH OF EXAMINATION AND PRESTIMULUS BLOOD PRESSURE

表4 反応値とHYPERREACTOR率の年齢・性・調査月・刺激前血圧別の有意差検定の結果

Test 検定	Age 年齢		Sex 性		Month of examination 調査月		Prestimulus blood pressure 刺激前血圧	
	<39	40+	Male 男	Female 女	Jun-Aug 6-8月	Sep-Oct 9-10月	<139	140+
<b>Systolic 収縮期</b>								
Mean value of response 反応の平均値	11.9	16.8	14.9	12.3	15.0	12.2	12.9	17.8
T-test T-検定	P<.001***		.01>P>.001**		P<.001***		P<.001***	
Hyperreactor rate 率 %	18.9	35.4	27.7	23.2	30.0	18.7	21.9	39.4
$\chi^2$ -test $\chi^2$ -検定	P<.001***		.05<P/.10 sugg		P<.001***		P<.001***	
<b>Diastolic 拡張期</b>								
Mean value of response 反応の平均値	12.3	12.7	13.6	11.6	13.6	11.1	13.1	11.2
T-test T-検定	.40<P<.50		P<.001***		P<.001***		.01>P>.001**	
Hyperreactor rate 率 %	35.5	36.3	41.3	31.7	41.1	28.6	38.5	30.3
$\chi^2$ -test $\chi^2$ -検定	.70<P<.80		P<.001***		P<.001***		.001<P<.01**	

TABLE 5 SYSTOLIC BLOOD PRESSURE RESPONSE, SAMPLE COMPOSITION, MEAN VALUE, AND RATE OF HYPERREACTOR, BY AGE, MONTH OF EXAMINATION, AND COMPARISON GROUP

表5 収縮期圧反応, 標本構成, 平均値とHYPERREACTOR率: 年齢・調査月・比較群別

Age 年齢	June-August 6-8月					September-October 9-10月					Total 計				
	Group 比較群				Total 計	Group 比較群				Total 計	Group 比較群				Total 計
	1	2	3	4		1	2	3	4		1	2	3	4	
<b>Sample composition 標本構成</b>															
15-39	99	108	104	90	401	92	78	74	76	320	191	186	178	166	721
40-81	69	66	59	54	248	45	51	50	41	187	114	117	109	95	435
Total 計	168	174	163	144	649	137	129	124	117	507	305	303	287	261	1156
<b>Mean value of response mmHg 反応の平均値</b>															
15-39	13.3	11.8	12.6	14.6	13.0	11.3	10.9	10.1	9.9	10.6	12.3	11.4	11.6	12.5	11.9
40-81	16.1	18.1	18.6	20.6	18.2	15.6	14.5	14.8	15.0	14.9	15.9	16.5	16.9	18.2	16.8
Total 計	14.5	14.2	14.8	16.9	15.0	12.7	12.3	12.0	11.7	12.2	13.7	13.4	13.6	14.5	13.8
<b>Hyperreactor rate 率 %</b>															
15-39	25.3	18.5	20.2	26.7	22.4	17.4	15.4	9.5	14.5	14.4	21.5	17.2	15.7	21.1	18.9
40-81	37.7	45.5	39.0	48.1	42.3	24.4	19.6	28.0	34.1	26.2	32.5	34.2	33.9	42.1	35.2
Total 計	30.4	28.7	27.0	34.7	30.0	19.7	17.1	16.9	21.4	18.7	25.6	23.8	22.6	28.7	25.1



TABLE 6 SYSTOLIC BLOOD PRESSURE RESPONSE, SAMPLE COMPOSITION, MEAN VALUE, AND RATE OF HYPERREACTOR BY AGE, SEX, AND COMPARISON GROUP

表6 収縮期圧反応, 標本構成, 平均値とHYPERREACTOR率: 年齢・性・比較群別

Age 年齢	Male 男					Female 女					Male+Female 男+女				
	Group 比較群				Total 計	Group 比較群				Total 計	Group 比較群				Total 計
	1	2	3	4		1	2	3	4		1	2	3	4	
<b>Sample composition 標本構成</b>															
15-39	80	77	62	36	255	111	109	116	130	466	191	186	178	166	721
40-81	58	66	69	43	236	56	51	40	52	199	114	117	109	95	435
Total 計	138	143	131	79	491	167	160	156	182	665	305	303	287	261	1156
<b>Mean value of response mmHg 反応の平均値</b>															
15-39	12.0	11.9	9.9	15.2	11.9	12.5	11.1	12.5	11.7	11.9	10.6	12.3	11.4	12.5	11.9
40-81	16.2	18.0	17.9	21.1	18.1	15.6	14.5	15.1	15.7	15.2	14.9	15.9	16.5	18.2	16.8
Total 計	13.8	14.7	14.1	18.4	14.9	13.6	12.2	13.1	12.8	12.9	12.2	13.7	13.4	14.5	13.8
<b>Hyperreactor rate 率 %</b>															
15-39	22.5	16.9	8.1	27.8	18.0	20.7	17.4	19.8	19.2	19.3	21.5	17.2	15.7	21.1	18.9
40-81	29.3	39.4	39.1	46.5	38.1	35.7	27.5	25.0	38.5	32.2	32.5	34.2	33.9	42.1	35.2
Total 計	25.4	27.3	24.4	38.0	27.7	25.7	20.6	21.2	24.7	23.2	25.6	23.8	22.6	28.7	25.1

TABLE 7 DIASTOLIC BLOOD PRESSURE RESPONSE, SAMPLE COMPOSITION, MEAN VALUE, AND RATE OF HYPERREACTOR BY MONTH OF EXAMINATION AND COMPARISON GROUP

表7 拡張期圧反応, 標本構成, 平均値とHYPERREACTOR率: 調査月・比較群別

Prestimulus blood pressure 刺激前の血圧	June-August 6-8月					September-October 9-10月					Total 計				
	Group 比較群				Total 計	Group 比較群				Total 計	Group 比較群				Total 計
	1	2	3	4		1	2	3	4		1	2	3	4	
<b>Sample composition 標本構成</b>															
<79	123	118	111	103	455	91	86	75	73	325	214	204	186	176	780
80+	45	56	52	41	194	46	43	49	44	182	91	99	101	85	376
Total 計	168	174	163	144	649	137	129	124	117	507	305	303	287	261	1156
<b>Mean value of response mmHg 反応の平均値</b>															
<79	12.5	12.9	14.4	16.4	13.9	12.5	11.3	12.3	11.4	11.9	12.5	12.2	13.6	14.3	13.1
80+	13.8	13.4	10.5	13.1	12.7	10.7	8.2	10.3	9.7	9.8	12.2	11.2	10.4	11.4	11.2
Total 計	12.9	13.0	13.2	15.5	13.6	11.9	10.3	11.5	10.8	11.1	12.4	11.9	12.5	13.3	12.5
<b>Hyperreactor rate 率 %</b>															
<79	36.6	32.2	48.6	58.3	43.3	34.1	31.4	32.0	28.8	31.7	35.5	31.9	41.9	46.0	38.5
80+	40.0	42.9	30.8	34.1	37.1	26.1	18.6	26.5	20.5	23.1	33.0	32.3	28.7	27.1	30.3
Total 計	37.5	35.6	42.9	51.4	41.4	31.4	27.1	29.8	25.6	28.6	34.8	32.0	37.3	39.8	35.8

TABLE 8 DIASTOLIC BLOOD PRESSURE RESPONSE, SAMPLE COMPOSITION, MEAN VALUE AND RATE OF HYPERREACTOR BY SEX, MONTH OF EXAMINATION, AND COMPARISON GROUP

表8 拡張期圧反応, 標本構成, 平均値とHYPERREACTOR率: 性・調査月・比較群別

Month 月	Male 男					Female 女					Male+Female 男+女				
	Group 比較群				Total 計	Group 比較群				Total 計	Group 比較群				Total 計
	1	2	3	4		1	2	3	4		1	2	3	4	
Sample composition 標本構成															
Jun-Aug 6-8月	67	87	62	52	268	101	87	101	92	381	168	174	163	144	649
Sep-Oct 9-10月	71	56	69	27	223	66	73	55	90	284	137	129	124	117	507
Total 計	138	143	131	79	491	167	160	156	182	665	305	303	287	261	1156
Mean value of response mmHg 反応の平均値															
Jun-Aug 6-8月	15.4	13.4	13.3	16.9	14.6	11.2	12.6	13.1	14.6	12.9	12.9	13.0	13.2	15.5	13.6
Sep-Oct 9-10月	12.6	12.4	12.5	12.8	12.5	11.2	8.6	10.3	10.1	10.0	11.9	10.3	11.5	10.8	11.1
Total 計	13.9	13.0	12.9	15.5	13.6	11.2	10.8	12.1	12.4	11.6	12.4	11.9	12.5	13.3	12.5
Hyperreactor rate 率%															
Jun-Aug 6-8月	50.7	37.9	43.5	53.8	45.5	28.7	33.3	42.6	50.0	38.6	37.5	35.6	42.9	51.4	41.4
Sep-Oct 9-10月	38.0	39.3	33.3	33.3	36.3	24.2	17.8	25.5	23.3	22.5	31.4	27.1	29.8	25.6	28.6
Total 計	44.2	38.5	38.2	46.8	41.3	26.9	26.2	36.5	36.8	31.7	34.8	32.0	37.3	39.8	35.8

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