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16. Abstract

In report number FAA-AM-71-19, an analysis was made of an eight-year interval change in several Framingham Heart Study (FHS) indicators of coronary heart disease (CHD) susceptibility as measured on 475 male air traffic control (ATC) personnel. The initial measurements were obtained from these personnel as ATC students in 1960-1963 and the subsequent data were obtained eight years later from their current aeromedical certification records. This analysis revealed a general trend of advancing relative susceptibility to CHD with age and obesity. Sample sizes (in age by obesity cells) were frequently too small to warrant any statement of significance for this general trend.

As a logical followup, analyses of similar data from 23,826 male ATC personnel and 424,333 male third-class airmen were accomplished. This report covers only the latter population segment. The data were obtained from current aeromedical certification records in January 1971. The distributions of resting blood pressure (BP), resting heart rate (HR) and the 400 pathology code prevalence were compiled in age versus Framingham relative weight index (FRWI) tables. In accordance with the FHS, obesity was defined as a minimum FRWI of 120.0%. Substantiating earlier findings all parameters generally increased with age and obesity. These findings are directly relevant to the mass aeromedical screening, early detection, susceptibility reversal and preventive aspects of CHD.

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THE USE OF SIMPLE INDICATORS FOR DETECTING POTENTIAL CORONARY HEART DISEASE SUSCEPTIBILITY IN THE THIRD-CLASS AIRMAN POPULATION

I. Introduction.

According to recent epidemiological statistics, arteriosclerotic heart disease, which includes coronary heart disease (CHD), caused 31.0% of all deaths in the United States.[1] A recent survey on silent CHD estimates its magnitude at a minimum of 5.0% in United States males over 35 years of age.[2] Other studies concerning the magnitude and age distribution of silent CHD in the general population have been reviewed in a previous report.[3] The Framingham Heart Study (FHS) has uncovered strong correlations between silent CHD and both sudden incapacitation and/or sudden death.[4] In view of the unexpectedness of most CHD deaths and the absence of a definite prior diagnosis of this disease, the FHS concludes that "the only road to a substantial reduction in premature CHD mortality is the prevention of this disease entity." In the category of sudden, unexpected death without a prior definite diagnosis of CHD, 80.0% of the victims had manifested risk clearly in at least one of the Framingham susceptibility indicators.[4]

In 1970, the FAA conducted the aeromedical certification examination of 444,000 airmen.[5] The repetitively examined airman population should contain less prevalent silent CHD than the 5.0% manifested by the general population. One way of detecting this maximum 5.0% aliquot is the comprehensive cardiological examination of approximately 444,000 airmen each year. Assuming one-hundred dollars per examination of this type, this solution for detecting the maximum 5.0% aliquot, at a cost of 44.4 million dollars per year, would be economically inefficient. This report presents and explores an alternative and more economical possible solution in the specific context of the third-class airman segment of the airman population. A similar report focused on the entire air traffic controller (ATC) population has been prepared.[3]

In a previous report, an analysis was made of an eight-year interval change in several Framingham indicators of CHD susceptibility as measured on 475 male ATC personnel.[6] The distribution of each of the Framingham parameters used was compiled in an age versus Framingham relative weight index (FRWI) table. The distributions of the initial 1960–1963 data revealed a general trend of increasing relative susceptibility with age and FRWI. This is consistent with the FHS findings of greater CHD susceptibility with advanced age and obesity.[7] The distributions of the eight-year interval data revealed the same general trend with age and FRWI, as well as an increased concentration of greater relative susceptibility in the older/obese combined categories. To test these earlier findings, an analysis of similar data from 424,333 male third-class airmen was accomplished. A similar analysis on 23,826 male ATC personnel has also been accomplished.[3]

II. Methods.

All data were obtained from the active aeromedical certification records in January 1971. The complete rationale of the age versus FRWI table format has been presented in a previous report.[6] Each table contains one total and four segmental age categories versus one total, one subtotal and three segmental FRWI categories. The FRWI was calculated from the Framingham formula using height in inches and weight in pounds. The parameters analyzed in the present study are resting systolic and diastolic blood pressures (SBP and DBP), resting heart rate (HR) and % prevalence of the 400 pathology code. The FAA codes all cardiovascular pathologies under the 400 series. The measurement methods for these four parameters have been presented in detail in a previous report.[3] The distribution of each of these four parameters was compiled in the age versus FRWI table.

III. Results.

Tables 1 and 2 present the age versus FRWI tabulations of mean SBP and mean DBP respectively. In the All FRWI's and All Ages columns of both tables, an increase in both SBP and DBP with increasing age and obesity are quite apparent. That age and obesity may be acting independently on the SBP and DBP is suggested strongly by the same pattern of increase within each of the age and FRWI segments. The summary tables of nine major population samplings of age versus blood pressure were examined in relevance to the All FRWI's data columns of Tables 1 and 2. Compared across age groups alone, the SBP and DBP values in Tables 1 and 2 were greater than those in four of these studies[8] and less than those in the remaining five.[8,10] In one of these population samplings[8] based on data from 235,000 males, a single table summary of age versus height and weight categories for resting SBP and DBP was compiled. Mathematical conversion of these height and weight data to FRWI equivalents for a subsequent comparison with equivalent age and FRWI categories in Tables 1 and 2 was accomplished. Compared on this basis, all the SBP and DBP values in Tables 1 and 2 were greater than those of the compared population study.[8] Per se, none of the SBP and DBP values in Tables 1 and 2 are considered to be medically abnormal.[8,10] The points of salient interest in Tables 1 and 2 are the increase in SBP and DBP with both age and obesity, and

FRWI (%)	AGE (yrs.) <30	30-39	40-49	>50	All Ages
<100.0	120.4 ±0.02 (124,337)	122.8 ±0.05 (52,612)	125.2 ±0.05 (45,658)	130.7 ±0.09 (22,249)	122.7 ±0.02 (244,856)
100.0–119.9	125.1 ±0.05 (44,287)	126.5 ±0.05 (45,114)	128.9 ±0.05 (46,677)	134.0 ±0.08 (21,835)	127.9 ±0.03 (157,913)
<120.0	121.6 ±0.02 (168,624)	124.5 ±0.03 (97,726)	127.1 ±0.04 (92,335)	132.3 ±0.06 (44,084)	124.7 ±0.02 (402,769)
≧120.0	130.9 ±0.16 (6,228)	131.8 ±0.15 (6,402)	133.6 ±0.15 (6,284)	138.1 ±0.26 (2,650)	132.8 ±0.08 (21,564)
All FRWIs	121.9 ±0.03 (174,852)	125.0 ±0.03 (104,128)	127.5 ±0.04 (98,619)	132.6 ±0.06 (46,734)	125.2 ±0.02 (424,333)

TABLE 1. Tabulation of Mean SBP Versus Age and FRWI Categories. Each table cell contains the mean SBP value (in mm Hg), the standard error of the mean (± mm Hg) and in parentheses, the number of data used in their calculation.

FRWI (%)	AGE (yrs.) <30	30-39	40-49	>50	All Ages
<100.0	73.1 ±0.02 (124,337)	76.0 ±0.03 (52,612)	77.7 ±0.04 (45,658)	79.4 ±0.06 (22,249)	75.3 ±0.02 (244,856)
100.0–119.9	76.4 ±0.03 (44,287)	78.6 ±0.03 (45,114)	80.2 ±0.04 (46,677)	81.9 ±0.05 (21,835)	78.9 ±0.02 (157,913)
<120.0	74.2 ±0.01 (168,624)	77.2 ±0.02 (97,726)	79.0 ±0.02 (92,335)	80.6 ±0.04 (44,084)	76.7 ±0.01 (402,769)
≧120.0	80.0 ±0.11 (6,228)	81.9 ±0.10 (6,402)	82.9 ±0.10 (6,284)	83.9 ±0.17 (2,650)	81.9 ±0.06 (21,564)
All FRWIs	74.4 ±0.01 (174,852)	77.5 ±0.02 (104,128)	79.2 ±0.02 (98,619)	80.9 ±0.03 (46,734)	77.0 ±0.01 (424,333)

TABLE 2. Tabulation of Mean DBP Versus Age and FRWI Categories. Each table cell contains the mean DBP (in mm Hg), the standard error of the mean (± mm Hg) and in parentheses the number of data used in their calculation.

the concentration of the higher blood pressure values in the combined older/obese categories.

Table 3 presents the age versus FRWI tabulation of mean resting HR values. Per se, none of the HR values in this table are considered to be medically abnormal.[9] In the All Ages and All FRWI's columns, an increase in HR with increasing age and obesity is present, although the increments of HR increase in the latter column are appreciably small. With few exceptions, a pattern of HR increase within each segmental age and FRWI category is present, again suggesting the possibility that age and obesity may be acting independently on the resting HR.

Table 4 presents the age versus FRWI tabulation of the 400 pathology code % prevalence. The parenthesized value in each table cell represents the % prevalence of the 400 pathology code. In the All Ages and All FRWI's columns of this table an increase in 400 pathology code % prevalence with increasing age and obesity is clearly manifested. That obesity and age may be acting independently on the 400 pathology code % prevalence is suggested strongly by the same pattern of increase within each age and FRWI segment. The increased concentration of this parameter in the combined older/obese categories is of paramount interest.

IV. Discussion.

In general corroboration of the findings presented in a previous report,[6] the trends of the parameters presented here in similar age versus FRWI tables support the presence of a relatively increasing CHD susceptibility with age and obesity in the third-class airman population.

FRWI (%)	AGE (yrs.) <30	30-39	40-49	>50	All Ages
<100.0	73.2 ±0.02 (124,337)	74.0 ±0.03 (52,612)	74.2 ±0.03 (45,658)	74.3 ±0.04 (22,249)	73.7 ±0.01 (244,856)
100.0-119.9	73.8 ±0.03 (44,287)	74.5 ±0.03 (45,114)	74.7 ±0.03 (46,677)	74.7 ±0.05 (21,835)	74.4 ±0.02 (157,913)
<120.0	73.4 ±0.01 (168,624)	74.2 ±0.02 (97,726)	74.4 ±0.02 (92,335)	74.5 ±0.02 (44,084)	73.9 ±0.01 (402,769)
≧120.0	75.9 ±0.10 (6,228)	76.2 ±0.09 (6,402)	75.9 ±0.09 (6,284)	75.8 ±0.14 (2,650)	76.0 ±0.05 (21,564)
All FRWIs	73.5 ±0.04 (174,852)	74.3 ±0.02 (104,128)	74.5 ±0.02 (98,619)	74.6 ±0.02 (46,734)	74.0 ±0.01 (424,333)

TABLE 3. Tabulation of Mean Resting HR Versus Age and FRWI Categories. Each table cell contains the mean resting HR (in beats per minute), the standard error of the mean (± beats per minute) and in parentheses, the number of data used in their calculation.

Further, a general concentration of the elevated parametric values reflecting the highest relative susceptibility to CHD occurs in the combined older/obese categories.

Although all the SBP and DBP values in Tables 1 and 2 appear to be somewhat below the threshold values for marked CHD susceptibility,[11] a general increase with age and obesity is apparent with a concentration of the higher values in the combined older/obese categories. Although the highest SBP and DBP values in the combined older/obese categories do not exceed the threshold values for marked CHD susceptibility,[11] it appears quite reasonable to assume that a greater relative CHD susceptibility exists in these categories than in the younger/thinner counterpart categories manifesting the lower SBP and DBP values. Over its 20 years of experience, the FHS has definitely established the prospective relationship of initial hypertensive levels of blood pressure (>160 mm Hg SBP and/ or >95 mm Hg DBP) to the subsequent development of overt CHD.[4 12 13] This relationship is a continuum which includes non-hypertensive levels of blood pressure.[13] As specifically stated in this particular FHS report[13] based on the first 14 of its 20 years of data: "Risk of every manifestation of CHD including angina, coronary insufficiency, myocardial infarction and sudden death was distinctly and impressively related to the antecedent level of both systolic and diastolic blood pressure. Risk was related not solely to 'hypertension' but was proportional to the level of blood pressure—even at non-hypertensive pressures—from the lowest to the highest recorded." Therefore, if covert CHD is present at all in the third-class airman population, it appears reasonable to assume that comprehensive

FRWI (%)	AGE (yrs.) <30	30-39	40-49	>50	All Ages
<100.0	885/124,337 (0.71)	512/52,612 (0.97)	710/45,658 (1.56)	722/22,249 (3.25)	2,829/244,856 (1.16)
100.0-119.9	459/44,287 (1.04)	493/45,114 (1.09)	891/46,677 (1.91)	716/21,835 (3.28)	2,559/157,913 (1.62)
<120.0	1,344/168,624 (0.80)	1,005/97,726 (1.03)	1,601/92,335 (1.73)	1,438/44,084 (3.26)	5,388/402,769 (1.34)
≧120.0	124/6,228 (1.99)	102/6,402 (1.59)	140/6,284 (2.23)	110/2,650 (4.15)	476/21,564 (2.21)
All FRWIs	1,468/174,852 (0.84)	1,107/104,128 (1.06)	1,741/98,619 (1.77)	1,548/46,734 (3.31)	5,864/424,333 (1.38)

TABLE 4. Tabulation of the 400 Pathology Code % Prevalence Versus Age and FRWI Categories. Each table cell contains the ratio of the 400 code prevalence number to the total number of cell individuals and in parentheses, the equivalent of the ratio in terms of % prevalence.

cardiological examination would most probably reveal a greater % prevalence of the CHD in the older/obese combined categories with the higher blood pressures than in the younger/thinner combined categories with the lower blood pressures.

A detailed rationale for the relationship between increased resting HR and CHD susceptibility has been presented in a previous report.[6] Although none of the HR values in Table 3 are considered to be medically abnormal,[9] a general pattern of increase with age and obesity is present. The increase in HR with age within each FRWI segment appears to be much smaller than the more consistent increase in HR with FRWI within each age segment. Exceptions to the pattern of HR increase with age occur in the 100–119.9% FRWI segment, in which it flattens out in the last two age groups and in the ≥120.0% FRWI segment, in which directional reversal occurs. No firm interpretation of these two exceptions is possible at this time. It is possible that the more consistent increase in HR with FRWI within each age segment could signify that the HR/obesity relationship may be more directly involved in CHD susceptibility than the HR/age relationship. The overall trend in Table 3 still supports an increasing relative CHD susceptibility with age and obesity with a concentration of the higher HR values in the combined older/obese categories.

Because of the unequivocal documented nature of 400 pathology code incidents, the data in Table 4 constitute the strongest evidence in support of the presence of an increasing relative CHD susceptibility with age and obesity and the concentration of the highest relative susceptibility in the older/obese combined categories. The gen-