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Michael T. Lategola, Ph.D.	
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16. Abstract

During 1960-1963, the Civil Aeromedical Research Institute (CAMI) conducted a broad spectrum of biomedical evaluations on a large number of air traffic control (ATC) students. Approximately 1270 of these students (20-50 years of age) underwent biodynamic evaluation of physical fitness. From these data, the relationships of maximum oxygen uptake ($M\dot{V}O_2$/Kg bw), resting SBP and DBP to age and the FRWI (an obesity indicator) were examined. General data trends indicated an increase in SBP and DBP with age and the FRWI. The $M\dot{V}O_2$/Kg bw showed a general trend of decrease as both age and the FRWI increased.

In 1970, approximately 475 of the original 1270 ATC students possessed current airman medical certificates. An average age increase of 8.3 years had occurred. Relevant data from the current aeromedical certification files were examined. The average weight gain was approximately nine percent. The 1970 resting SBP and DBP also increased with both age and the FRWI. The percent incidence of the 400 pathology code, as well as resting exercise and recovery heart rates, increased with age and the FRWI.

An overall pattern has emerged which indicates an advancing relative susceptibility to coronary heart disease (CHD) in those individuals with a combination of advanced age and obesity. Corroboration in a larger population sample is being pursued. If corroborated, this pattern would have direct use in the areas of mass aeromedical screening, early detection, susceptibility reversal and preventive maintenance aspects of CHD.

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CHANGES IN CARDIOVASCULAR HEALTH PARAMETERS OVER AN EIGHT-YEAR INTERVAL IN AN ATC POPULATION SEGMENT

I. Introduction.

During 1960–1963, the Civil Aeromedical Research Institute (CARI) conducted a broad spectrum of biomedical evaluations on a large number of air traffic control (ATC) students. Approximately 1,270 of these students (20–50 years of age) underwent biodynamic testing of physical fitness. This testing included adjunct measurements of height, weight, pulmonary vital capacity (VC) and maximum breathing capacity (MBC) as well as maximum aerobic work capacity in terms of the maximum oxygen uptake per kilogram body weight ($M\dot{V}O_2$/Kg bw).[1] These data were collected as baselines for subsequent evaluations of the students after they had become career ATC personnel. The subsequent evaluations were planned as assessments of longitudinal changes associated with chronological aging and health related aspects of job performance.

In 1967, a five-year biomedical followup task was initiated. The ATC students who had become career personnel were somewhat randomly distributed throughout the various tower and enroute centers of the air traffic system. Two of the largest concentrations of biomedical followup candidates (14 apiece) were located at two California enroute centers. The followup evaluations of these two groups were to be conducted in-house at the Civil Aeromedical Institute (CAMI) in Oklahoma City. In very short order, it became apparent that, because of combined difficulties in ATC leave scheduling, biorhythmic/environmental displacements and travel logistics, the return of these personnel to the Civil Aeromedical Research Institute for followup evaluations would be grossly inefficient in cost and time, as well as biologically undesirable. The same logic would apply to other personnel concentrations with similarly distant geographic locations.

Serious consideration was given to field testing at the geographic sites of substantial personnel concentrations. This was deemed unfeasible when considered in terms of the travel logistics of in-house equipment and research personnel, as well as the total time which would be needed to process geographically a reasonable number of followup candidates.

Further examination of the geographic distribution of personnel revealed that a small but useful number of followup candidates was located at the Kansas City and Fort Worth enroute centers. Of these candidates, a total of 20 volunteered to return to CAMI for the evaluation. The evaluation of these 20 personnel in-house was deemed feasible because of the relatively short travel time between each of these centers and Oklahoma City, and because of their general biorhythmic/environmental compatibility with the Oklahoma City area. When these 20 personnel were subsequently evaluated, orthostatic tolerance (tilt table) as well as resting and exercise electrocardiography testing were employed in addition to those procedures used in the 1960–1963 period. A segmental separate report will cover the results of these 20 followup evaluations.

In the 20 years since its 1950 inception,[2] the Framingham Heart Study (FHS) has succeeded in delineating an extensive battery of quantifiable indicators of gradational susceptibility to coronary heart disease (CHD). This battery of indicators has become well known as the "coronary profile".[3] In 1970, as a facet of in-house research on early detection of cardiovascular disease in aviation personnel, the data obtained from the ATC students in the 1960–1963 period were reviewed and found to contain several of the FHS indices.

For males, the FHS data have clearly shown that increased age and obesity each confer increased susceptibility to CHD.[4, 5] In the 1960–1963 ATC data, age was available as a directly recorded item and the degree of obesity in terms of the Framingham Relative Weight Index (FRWI) was assessable from directly measured height and weight data. Our 1960–1963 determinations of resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) were assessable in relation to the FHS finding of increased CHD susceptibility conferred by elevated blood pressure.[6] The reported inverse relationship between level of physical activity and CHD susceptibility[7] was assessable in terms of our 1960–1963 measurements of $\dot{M}VO_2$/Kg bw. The directly proportional relation of this latter item to physical activity capacity is well established.[8 9]

According to one of the FHS reports,[4] the twelve-year incidence rate of CHD in their male subjects with an entry age of 40–49 years was 2.33 times that of their comparable 30–39 year old group. Another FHS report arbitrarily defined frank obesity as an FRWI of 120% or greater.[5] In this report covering males of 30–59 years of age at study entry,[5] the twelve-year risk of the 120% or greater FRWI group for development of CHD was 1.78 times that of the 90–109% FRWI group. In the same report,[5] further comparisons of the same two FRWI groups over the same twelve-year period revealed that the risk of the obese group for development of angina pectoris (AP) was 2.09 times that of the non-obese group and the risk of those in the obese category for sudden CHD death was 5.06 times that of the non-obese category. In an earlier FHS report,[10] sudden death was defined as a sub category of CHD in which death occurred in a matter of minutes in persons apparently well. Therefore, it is conservatively apparent that age beyond 40 years and obesity of an FRWI of 120% or greater are at least associated with a substantially increased susceptibility to CHD. The possibility that obesity, *per se*, has a causal as well as an associative relation to the development of CHD and its sequelae is strongly supported by the evidence that the risk of CHD increases further when other risk factors are superimposed upon obesity.[4]

Since neither age nor obesity, *per se*, are disqualifying according to aeromedical certification standards, a wide distribution spectrum of each of these two parameters in the ATC and/or any other substantial segment of the airman population is a reasonable expectancy. Because of the expected wide distribution of these two factors and because of their reported association with CHD susceptibility,[4 5] it seemed reasonable to examine the quantitative distributions of the FRWI, SBP, DBP, and $\dot{M}VO_2$/Kg bw in an age versus FRWI table format. This analysis could expose CHD factorial interrelationships, if present, in the 1960–1963 ATC student data.

Because height and weight (FRWI determinants), age, as well as SBP and DBP data are routinely obtained and recorded as an integral part of the annual ATC medical certification procedure, this affords an identical analysis of current values of these same parameters obtained during the current medical examinations of those ATC students who had subsequently become career ATC personnel. A current analysis of the identical factors could reveal the temporal progress, if any, of whatever CHD factorial interrelationships existed in the 1960–1963 period. Since $\dot{M}VO_2$/Kg bw is inversely related to resting, fixed-level submaximum exercise and post exercise recovery heart rates (HR),[11] and since these three HR measurements are also obtained and recorded as a routine portion of the annual ATC medical examination, the analysis of their current values seemed warranted in relevance to the 1960–1963 $\dot{M}VO_2$/Kg bw data.

Of the 1,270 ATC students who underwent biodynamic testing in the 1960–1963 period, approximately 870 completed their ATC training successfully. Of these 870 graduates, date of birth (age determinant) along with height and weight (FRWI determinants) were obtained on only 653 of them in the 1960–1963 period. A search of the active medical certification files in 1970 revealed 475 of the 1960–1963 graduates who were currently ATC personnel and whose medical certification records contained age, height, weight and adjunct data. The age versus FRWI parametric tabulations representing the 1960–1963 and the 1970 time periods respectively were restricted to the data obtained from the original 475 ATC students who were still present as career personnel in 1970.

Because of its direct relevance and availability from the current medical cetification files, an age versus FRWI tabulation of the incidence of cardiovascular pathology of the 400 series was also included in the analysis of the 1970 data. Although VC and MBC were measured in the 1960–1963 period,[1] these two parameters were omitted from this analysis because data for the 1970 period were not available.

II. Methods.

1960–1963 Data—Utilizing date of birth, age was calculated and expressed as the nearest completed year on the day of biodynamic testing. Unclothed height and weight were measured to the nearest quarter inch and quarter pound respectively. The SBP and DBP were measured under seated, resting conditions using standard equipment and technique.[12] $M\dot{V}O_2$/Kg bw was determined by any one of four equivalent methods[1] and converted to standard conditions of temperature and pressure, dry (STPD). A detailed description of the 1960–1963 data acquisition methods has been previously reported.[1]

1970 Data—All 1970 data were obtained from the active medical certification files as they existed in May of 1970. Age was expressed as the nearest completed year on the day of the medical examination. As recorded in the medical certification files, height and weight are stated rather than measured quantities. Since directly measured height is far more accurate than stated height, the 1970 heights were calculated from the measured 1960–1963 heights and an anthropometric correction factor for the expected height decrement over an eight-year interval.[13] Stated weight, as obtained and recorded in the medical certification files, is subject to error. Two comprehensive studies[14 15] have reported that heavy men tend to underestimate their weights while light ones tend to overestimate theirs. Because neither corroboration of a stated weight error nor appropriate correction factors are available at this time for this specific ATC population segment, the uncorrected stated weights were used as the best available data. However, because of the nature of the age versus FRWI tables, the quantitation of any parameter which changes in direct proportion to the FRWI will tend to yield conservative estimates at the polar FRWI extremes.

The 1970 resting SBP and DBP data were presumably obtained under standard conditions of accuracy comparable with those of the 1960–1963 period. As described in the ATC medical examination procedure, the resting HR is measured immediately following cessation of a standard submaximum exercise and the recovery HR is measured two minutes following exercise termination.

The 1965 revised pathology codes of the aviation medical service list all cardiovascular pathology under the 400 series. This series contains designated critical and non-critical pathologies. Once documented and coded, critical items are permanently retained in the individual's medical certification file. Non-critical items may be found in the individual's current file only if they are currently present. In this analysis, no distinction was made between critical and non-critical code items. However, it appears reasonable to assume that the presence of any 400 series item would generally confer a greater cardiovascular susceptibility than its absence.

Age Versus FRWI Tables—The general rationale of this table format has been presented. Five-year age brackets were arbitrarily chosen as serving best the purposes of this analysis. The FRWI brackets were limited arbitrarily to three ranges (and two combinations thereof) which were grossly representative of the total spectrum of this parameter. The three separate FRWI ranges chosen were: less than 100.0%, 100.0–119.9% and 120% or greater. An FRWI of 100.0% indicates that the weight of the individual is equal to the median weight of the FHS males of his height at the 1950 inception of the FHS.[16] The rationale and formulae for the calculation of the FRWI have been reported previously.[16] The use of the FRWI for this present analysis is based on the assumption of population segment similarity at study inception.

Because many of the individual cells in the age versus FRWI tables of analysed parameters were represented by too few numbers of data, and because the total number of 1970 data was not always equal to that of the 1960–1963 data used for each parametric analysis, the testing of inter-cell differences for statistical significance was not warranted. Therefore, inter-cell comparisons were restricted to an examination of the overall trend of the individual parametric changes with respect to increases in age and FRWI.

III. Results.

An average age increase of 8.3 years had occurred in the 475 ATC personnel between the 1960–1963 and 1970 time periods respectively. Over the 8.3 year interval, this group had manifested an average weight gain of 9.7% even though ten percent of the group had lost weight in the same time period. The youngest age group (20–29 years in 1960–1963) manifested the largest average weight gain of 10.7% in the 8.3 year interval. In a 1960–1962 United States population study,[17] the average weight gain of a comparable age group of males over the same time interval was 6.9%. This information may be useful in martialling an age-focused educational effort against excessive weight gain since the 20–29 year old group constituted 80.6% of the 475 ATC personnel.

FRWI (%)	AGE (yrs.) 20-24	25-29	30-34	35-39	40-44	45-49	All Ages
<100.0	86.8 (198)	87.4 (107)	89.4 (36)	90.6 (21)	94.6 (7)	93.0 (1)	87.6 (370)
100.0–119.9	106.9 (35)	106.3 (35)	105.5 (11)	106.5 (7)	105.3 (5)	106.0 (1)	106.4 (94)
<120.0	89.8 (233)	92.1 (142)	93.2 (47)	94.6 (28)	99.0 (12)	99.5 (2)	91.4 (464)
≧120.0	122.6 (3)	123.9 (5)	122.5 (2)	121.3 (1)	(0)	(0)	123.0 (11)
All FRWIs	90.2 (236)	93.2 (147)	94.4 (49)	95.5 (29)	99.0 (12)	99.5 (2)	92.1 (475)

Table I-FRWI-I

TABLE 1. Tabulation of mean FRWI versus age and FRWI categories. These data represent the 1960–1963 period. Each Table cell contains the mean FRWI value (in percent) and immediately below it (in parentheses) the the number of data used in its calculation.

Table 1 presents the age versus FRWI compilation of mean FRWI for the 1960–1963 period and Table 2 presents its counterpart for the 1970 period. Over the 8.3 years, the mean FRWI of the entire group increased from a value of 92.1 to 101.5. Visual examination of the data in both tables reveals that, over the 8.3 year period, a general trend of increasing FRWI toward obesity had apparently occurred, as well as an increase in the number of individuals manifesting the greater FRWI increases.

The age versus FRWI tabulation of mean SBP representing the 1960–1963 period is presented in Table 3 and its 1970 counterpart is presented in Table 4. The entire spectrum of SBP values in both of these tables lies within the norm range for the general population of the United States.[15] An examination of the All FRWIs category in both tables reveals a general trend of increase in mean SBP with age. This type and degree of increase is not unusual.[15] Scrutiny of the All Ages column in both tables reveals a more defined trend of increase in mean SBP as the FRWI increases toward obesity. This increase in SBP with obesity cannot be attributed to age alone, for the same general trend of increase is revealed in each of the segmental age-range columns of both tables. Although the

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	90.5 (6)	92.5 (148)	91.4 (47)	90.8 (13)	93.2 (11)	94.7 (5)	92.2 (230)
100.0–119.9	103.9 (3)	107.4 (124)	108.9 (56)	107.2 (15)	108.2 (16)	102.7 (2)	107.7 (216)
<120.0	94.9 (9)	99.3 (272)	100.9 (103)	99.6 (28)	102.1 (27)	97.0 (7)	99.7 (446)
≧120.0	(0)	128.8 (18)	128.5 (6)	129.6 (2)	128.5 (2)	121.0 (1)	128.5 (29)
All FRWIs	94.9 (9)	101.1 (290)	102.4 (109)	101.6 (30)	103.9 (29)	100.0 (8)	101.5 (475)

Table 2 - FRWI-II

TABLE 2. Tabulation of mean FRWI versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the mean FRWI value (in percent) and immediately below it (in parentheses) the number of data used in its calculation.

total spectrum of these mean SBP values lies within norm range [15] and the type and general degree of increases with both age and obesity are not unusual,[15] it is of salient interest to point out that the highest of these SBP values, proceeding in the direction of undesirable elevation, tend to be concentrated in the combined older/obese categories.

The age versus FRWI tabulation of mean DBP for the 1960–1963 period is shown in Table 5 and its counterpart for 1970 is shown in Table 6. The entire spectrum of DBP values in both of these tables lies within the norm range for the general population of the United States.[15] In parallel behavior with the mean SBP, a general trend of increase in mean DBP with both age and obesity is also apparent in these two tables. In further similarity, the increase in mean DBP with obesity is generally manifested in each of the segmental age-range columns. Also warranted is the same point of interest that, despite the overall norm range of these DBP values [15] and overall norm range of increase with age and obesity,[15] the highest DBP values, in the direction of undesirable elevation, again tend to be concentrated in the combined older/obese categories.

The tabulation of mean $\dot{M}VO_2$/Kg bw in the age versus FRWI format for the 1960–1963 period is shown in Table 7. According to the Balke rating scale for United States males,[18] all the values of $\dot{M}VO_2$/Kg bw in this table lie within the Poor and Average categories of physical fitness. As previously stated,[8 9] decreasing $\dot{M}VO_2$/Kg bw reflects decreasing physical fitness. FHS studies have also reported that decreased physical fitness is associated with increased CHD susceptibility.[3 7] Examination of the All FRWIs and All Ages columns in Table 7 reveals a general trend of decrease in $\dot{M}VO_2$/Kg bw with age and obesity. The possibility

FRWI (%)	AGE (yrs.) 20-24	25-29	30-34	35-39	40-44	45-49	All Ages
<100.0	122.0 (46)	118.5 (21)	123.4 (8)	122.5 (2)	134.0 (1)	110.0 (1)	121.2 (79)
100.0–119.9	121.8 (6)	122.7 (13)	126.3 (3)	(0)	(0)	(0)	123.0 (22)
<120.0	122.0 (52)	120.1 (34)	124.2 (11)	122.5 (2)	134.0 (1)	110.0 (1)	121.6 (101)
≧120.0	130.0 (1)	132.8 (4)	110.0 (1)	(0)	(0)	(0)	128.5 (6)
All FRWIs	122.1 (53)	121.5 (38)	123.0 (12)	122.5 (2)	134.0 (1)	110.0 (1)	122.0 (107)

Table 3- SBP-I

TABLE 3. Tabulation of mean SBP versus age and FRWI categories. These data represent the 1960–1963 period. Each Table cell contains the mean SBP value (in mm Hg) and immediately below it (in parentheses) the number of data used in its calculation.

that age and obesity may be making separate contributions to the decrease in $M\dot{V}O_2$/Kg bw is suggested by the general presence of the same trend within each of the segmental age and FRWI categories. The point of paramount interest is the general tendency of an overall concentration of the lower $M\dot{V}O_2$/Kg bw values (lower physical fitness) in the combined older/obese categories.

In the 1970 period, the only available data having relevance to the 1960–1963 $M\dot{V}O_2$/Kg bw data were the resting, exercise and recovery HRs. As previously indicated,[11] physical fitness is inversely related to the HR at rest, at fixed-levels of submaximum exercise and at fixed-intervals of post-exercise recovery. The age versus FRWI tabulations of mean resting HR, mean exercise HR and mean recovery HR for the 1970 period are presented in Tables 8, 9, and 10 respectively. In these tables, there appears to be a general trend of increase in all three HR parameters with age and obesity. In concordance with the 1960–1963 $M\dot{V}O_2$/Kg bw data, these HR data appear to indicate a general trend of decreasing physical fitness with age and obesity, as well as a tendency for a concentration of this condition in the older/obese categories. These trends may bear additional importance if considered from the viewpoint that the 1960–1963 $M\dot{V}O_2$/Kg bw data already indicated undesirably low physical fitness baselines[18] from which further decreases in physical fitness may have occurred. The directional relation of these three HR parameters to decreasing physical fitness is well established.[8 9 19–22] The inverse relationship of physical fitness to CHD susceptibility has been clearly established by the FHS.[3 7 23]

The age versus FRWI tabulation of the 400 pathology code incidence for the 1970 period is presented in Table 11. The parenthesized value

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	120.0 (6)	121.4 (148)	119.0 (47)	122.5 (13)	115.6 (11)	122.0 (5)	120.6 (230)
100.0–119.9	113.3 (3)	123.4 (124)	124.9 (56)	126.7 (15)	133.0 (16)	129.0 (2)	124.7 (216)
<120.0	117.8 (9)	122.3 (272)	122.2 (103)	124.8 (28)	125.9 (27)	124.0 (7)	122.6 (446)
≧120.0	(0)	131.1 (18)	131.3 (6)	128.0 (2)	149.0 (2)	110.0 (1)	131.4 (29)
All FRWIs	117.8 (9)	122.7 (290)	122.8 (109)	125.0 (30)	127.5 (29)	122.3 (8)	123.2 (475)

Table 4 - SBP-II.

TABLE 4. Tabulation of mean SBP versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the mean SBP value (in mm Hg) and immediately below it (in parentheses) the number of data used in its calculation.

in each Table cell represents the percent incidence of 400 code pathology. Because eliminative occurrences of 400 code pathologies are not documented in the data repository of this population segment, a total incidence number of only 13 in these 475 ATC personnel is not surprising. Despite this small absolute incidence of only 13, Table 11 reveals a general trend of increase in the percent incidence of cardiovascular pathology with age and obesity in the All FRWIs and All Ages columns, as well as in their respective smaller segmental categories. The directional trend of this parameter appears to be consistent with the trends of the other parameters similarly analyzed.

IV. Discussion.

The general trends of all the parameters examined in the age versus FRWI table format appear to support the presence of a relatively increasing CHD susceptibility with age and obesity in this ATC population segment. Further, there appears to be a consistent general concentration of those parametric values reflecting the greatest relative susceptibility to CHD in the combined older/obese categories. Over the 8.3 year period, the quantitative increases in the FRWI as well as the increased number of individuals in the obese category appears to be evidence reflecting an advancing relative susceptibility to CHD.

Although the spectra of SBP and DBP values were well below the hypertensive thresholds of marked CHD susceptibility,[4] the actual values indicated a general increase with age and obesity, the higher values were generally concentrated in the combined older/obese categories and both spectra shifted upwards over the 8.3 year period.

The appearance of a general trend of decrease in $\dot{M}VO_2$/Kg bw with age and obesity, and a

FRWI (%)	AGE (yrs.) 20-24	25-29	30-34	35-39	40-44	45-49	All Ages
<100.0	77.9 (46)	78.2 (21)	81.8 (8)	82.0 (2)	88.0 (1)	80.0 (1)	78.6 (79)
100.0–119.9	76.7 (6)	81.2 (13)	85.0 (3)	(0)	(0)	(0)	80.5 (22)
<120.0	77.8 (52)	79.4 (34)	82.6 (11)	82.0 (2)	88.0 (1)	80.0 (1)	79.0 (101)
≧120.0	96.0 (1)	90.3 (4)	70.0 (1)	(0)	(0)	(0)	87.8 (6)
All FRWIs	78.1 (53)	80.5 (38)	81.6 (12)	82.0 (2)	88.0 (1)	80.0 (1)	79.5 (107)

Table 5 - DBP-I

TABLE 5. Tabulation of mean DBP versus age and FRWI categories.. These data represent the 1960–1963 period. Each Table cell contains the mean DBP value (in mm Hg) and immediately below it (in parentheses) the number of data used in its calculation.

general concentration of the lower values of this parameter in the combined older/obese categories are relatively stronger evidences for directionally commensurate CHD susceptibility in light of the relatively poor initial physical fitness levels.[18] The 1970 HR data appear to corroborate the $\dot{M}VO_2$/Kg bw indication of decreased physical fitness with age and obesity. The HR data may possibly indicate a further decrease in physical fitness over the 8.3 year period in light of the concomitant increases which occurred in the FRWI. Decreased physical fitness is usually associated with increased obesity. Evidence of a further decrease in physical fitness would serve to strengthen the notion of increased relative susceptibility to CHD as reflected by the FHS reports empirically linking poor physical fitness to increased CHD susceptibility.[3 7 23]

The strongest evidence for increasing relative CHD susceptibility is, of course, provided by the 400 pathology code incidence. Although only 13 of the 475 ATC personnel manifested 400 code pathologies, the overall pattern relating percent incidence to age and obesity was rather remarkable. The inherent strength of this evidence is not subject to conjecture, for the presence of a 400 coded item in the individual's record is based on a documented medical diagnosis. Therefore, based on all the parameters analyzed, an overall consistent pattern has emerged which relates relatively increasing CHD susceptibility to advanced age and obesity in this ATC population segment. Since this pattern is based on a relatively small population sample of 475 individuals, statements stronger than those describing general directional trends are not presently warranted. However, since age, height, weight, SBP, DBP, the 400 pathology code, as well as resting, exercise and recovery HRs are routinely obtained and recorded in all ATC medical examinations, and

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	71.0 (6)	73.8 (148)	75.7 (47)	77.2 (13)	72.4 (11)	79.2 (5)	74.3 (230)
100.0-119.9	72.0 (3)	77.1 (124)	77.8 (56)	80.7 (15)	84.6 (16)	81.0 (2)	78.0 (216)
<120.0	71.3 (9)	75.3 (272)	76.9 (103)	79.0 (28)	79.6 (27)	79.7 (7)	76.1 (446)
≧120.0	(0)	82.8 (18)	78.7 (6)	80.5 (2)	97.5 (2)	64.0 (1)	82.1 (29)
All FRWIs	71.3 (9)	75.7 (290)	77.0 (109)	79.1 (30)	80.8 (29)	77.8 (8)	76.5 (475)

Table 6 - DBP-II

TABLE 6. Tabulation of mean DBP versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the mean DBP value (in mm Hg) and immediately below it (in parentheses) the number of data used in its calculation.

since the total ATC population currently numbers in excess of 20,000 personnel, a similar analysis of the whole ATC population would statistically test the general validity of the inter-parametric relationships reported here. If such an analysis should confirm the general pattern observed here, only the consistency of these inter-parametric relationships will have been corroborated. The general pattern could also be statistically tested in other major segments of the airman population. The corroborated presence of relatively increasing CHD susceptibility for the whole ATC population would still not delineate the actual degree of susceptibility in concrete terms such as mortality and/or morbidity ratios. In order to obtain definitive information of this nature, a prospective study would be necessary. An initial population sample of statistically appropriate size and composition, initially free of CHD, would have to be followed temporally for the actual incidence rate of subsequently documented occurrences of CHD. If, following a reasonable time period, an examination of the age versus FRWI tabulation of percent CHD incidence revealed an age versus obesity relationship consonant with the parametric trends of this report, then corroboration and quantification would have been achieved simultaneously. Corroboration of this general pattern could be of extreme practical value.

If actual CHD susceptibility of a significant degree were clearly delineated by a combination of quantitative threshold values of the parameters in this report, the delineation of the susceptible portion of each major segment of the airman population would have major relevance to aviation safety. In terms of CHD screening in an airman population currently numbering approximately 725,000,[24] a delineation of such susceptibility based on the measurement of such

FRWI (%)	AGE (yrs.) 20-24	25-29	30-34	35-39	40-44	45-49	All Ages
<100.0	39.4 (194)	38.2 (107)	37.1 (33)	35.5 (20)	35.8 (7)	34.5 (1)	38.5 (362)
100.0–119.9	37.0 (33)	36.8 (34)	34.8 (11)	35.8 (7)	37.9 (4)	(0)	36.6 (89)
<120.0	39.0 (227)	37.9 (141)	36.5 (44)	35.6 (27)	36.6 (11)	34.5 (1)	38.1 (451)
≧120.0	35.2 (3)	31.0 (5)	33.0 (2)	33.5 (1)	(0)	(0)	32.7 (11)
All FRWIs	39.0 (230)	37.6 (146)	36.3 (46)	35.5 (28)	36.6 (11)	34.5 (1)	38.0 (462)

Table 7- $M\dot{V}O_2$/Kg bw-I

TABLE 7. Tabulation of mean $M\dot{V}O_2$/Kg bw versus age and FRWI categories. These data represent the 1960–1963 period. Each Table cell contains the mean $M\dot{V}O_2$/Kg bw value (in ml/min./Kg) and immediately below it (in parentheses) the number of data used in its calculation.

simple parameters as age, height, weight, SBP, DBP, and HR would seem to be highly desirable. A more focused effort could be afforded to the aviation medical examiner for the detection of any form of CHD which would be incompatible with the safe conduct of airman/ATC activities. Such focused efforts could include the assessment of any or all of the remaining documented indices from the FHS coronary profile.[3] This could provide an enhanced capability for early detection of incipient CHD.

Where a strong indication of CHD susceptibility appeared to be present, but no form of CHD, *per se*, were diagnosed, educational options could be exercised in the direction of susceptibility reversal for return to a fully optimum state of cardiovascular health. Finally, if absolute threshold values for susceptibility parameters were delineated for all the segments of the airman population, an extension of educational efforts would be logical in order to fully establish the concept of preventive maintenance of optimum cardiovascular health. An educational effort aimed at the reversal of CHD susceptibility and at preventive maintenance of optimum cardiovascular health would be of particular relevance for ATC personnel as an integral portion of FAA Order 9430.2A which established a specific program of health maintenance on their behalf. The degree to which this is achieved in all the major segments of the airman population should be reflected in the enhancement of aviation safety.

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	74.5 (6)	73.3 (147)	72.4 (47)	74.8 (13)	74.7 (11)	77.2 (5)	73.4 (229)
100.0-119.9	69.3 (3)	73.6 (124)	75.6 (56)	74.0 (15)	75.0 (16)	70.0 (2)	74.2 (216)
<120.0	72.8 (9)	73.4 (271)	74.2 (103)	74.4 (28)	74.9 (27)	75.1 (7)	73.8 (445)
≧120.0	(0)	75.6 (18)	70.0 (5)	75.0 (2)	87.0 (2)	84.0 (1)	75.6 (28)
All FRWIs	72.8 (9)	73.6 (289)	74.0 (108)	74.4 (30)	75.7 (29)	76.3 (8)	73.9 (473)

Table 8 - Resting HR-II

TABLE 8. Tabulation of mean resting HR versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the mean resting HR value (in beats/min.) and immediately below it (in parentheses) the number of data used in its calculation.

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	102.2 (6)	97.2 (147)	92.1 (47)	96.5 (13)	94.2 (11)	106.0 (5)	96.3 (229)
100.0-119.9	89.3 (3)	97.8 (124)	97.8 (56)	97.6 (15)	97.6 (16)	100.0 (2)	97.6 (216)
<120.0	97.9 (9)	97.4 (271)	95.2 (103)	97.1 (28)	96.2 (27)	104.3 (7)	96.2 (445)
≧120.0	(0)	104.0 (18)	91.2 (5)	101.0 (2)	106.0 (2)	104.0 (1)	101.7 (28)
All FRWIs	97.9 (9)	97.9 (289)	95.0 (108)	97.3 (30)	96.9 (29)	104.3 (8)	97.2 (473)

Table 9-Exercise HR-II

TABLE 9. Tabulation of mean exercise HR versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the mean resting HR value (in beats/min.) and immediately below it (in parentheses) the number of data used in its calculation.

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	75.7 (6)	74.3 (147)	73.9 (47)	75.7 (13)	75.1 (11)	76.8 (5)	74.4 (229)
100.0-119.9	82.0 (3)	74.6 (124)	76.6 (56)	75.0 (15)	75.1 (16)	73.0 (2)	75.0 (216)
<120.0	77.8 (9)	74.4 (271)	74.9 (103)	75.3 (28)	75.1 (27)	75.7 (7)	74.7 (445)
≧120.0	(0)	77.9 (18)	70.4 (5)	77.0 (2)	88.0 (2)	86.0 (1)	77.5 (28)
All FRWIs	77.9 (9)	74.6 (289)	74.7 (108)	75.4 (30)	76.0 (29)	77.0 (8)	74.9 (473)

Table 10-Recovery HR-II

TABLE 10. Tabulation of mean recovery HR versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the mean resting HR value (in beats/min.) and immediately below it (in parentheses) the number of data used in calculation.

FRWI (%)	AGE (yrs.) 25-29	30-34	35-39	40-44	45-49	50-54	All Ages
<100.0	0/6 (0)	2/148 (1.4)	1/47 (2.1)	0/13 (0)	1/11 (9.1)	0/5 (0)	4/230 (1.7)
100.0–119.9	0/3 (0)	3/124 (2.4)	1/56 (1.8)	0/15 (0)	1/16 (6.3)	1/2 (50.0)	6/216 (2.8)
<120.0	0/9 (0)	5/272 (1.8)	2/103 (1.9)	0/28 (0)	2/27 (7.4)	1/7 (14.3)	10/446 (2.2)
≧120.0	0/0 (0)	0/18 (0)	2/6 (33.3)	0/2 (0)	1/2 (50.0)	0/1 (0)	3/29 (10.3)
All FRWIs	0/9 (0)	5/290 (1.7)	4/109 (3.7)	0/30 (0)	3/29 (10.3)	1/8 (12.5)	13/475 (2.7)

Table 11 - 400 Path. Code - II

TABLE 11. Tabulation of 400 pathology code incidence versus age and FRWI categories. These data represent the 1970 period. Each Table cell contains the ratio of the 400 code incidence number to the total number of cell individuals and immediately below it (in parentheses) the equivalent of the ratio in terms of percent incidence.

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