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Psychosocial Factors in Coronary Heart Disease

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Despite the seeming complexity and size of modern organizations we still find that single individuals often exercise critical influence in terms of the unique expertise and understanding they develop in their particular roles. It takes months, even years before a top administrator or a scientist fully begins to understand all of the subtle, yet important nuances which surround his work. When such a valuable person, a human asset, dies before retirement, the organization suffers a valuable loss (one which to this day we are unable to measure in dollars or in accomplishment of the mission). No amount of financial insurance can reimburse an organization against such loss, particularly under conditions where there are deadlines to be met and little time to train replacements. Under such conditions, and they appear to be more frequent in the fast-moving modern world, the best form of insurance is to prevent premature death among the members of the organization. Coronary heart disease is one of the most prevalent forms of pre-retirement death in modern organizations. The aim of our current research is to contribute to such insurance by identifying risk factors in coronary heart disease which will be useful in preventive medicine.

Over the past twenty years, evidence has mounted suggesting that the incidence of heart disease varies from one broadly-defined social condition to another (socio-economic class, blue vs. white collar, rural vs. urban) and from one occupation to another. If we ever hope to be able to prevent or reduce the incidence of coronary heart disease within an organization, however, we must turn our attention to attributes of the environments which are more specific than social class or occupation. We cannot prevent heart disease by eliminating those social classes or occupations which have a high risk. However, if we can identify those particular job stresses which produce the risk, then we may be able to reduce these stresses and thus control the disease.

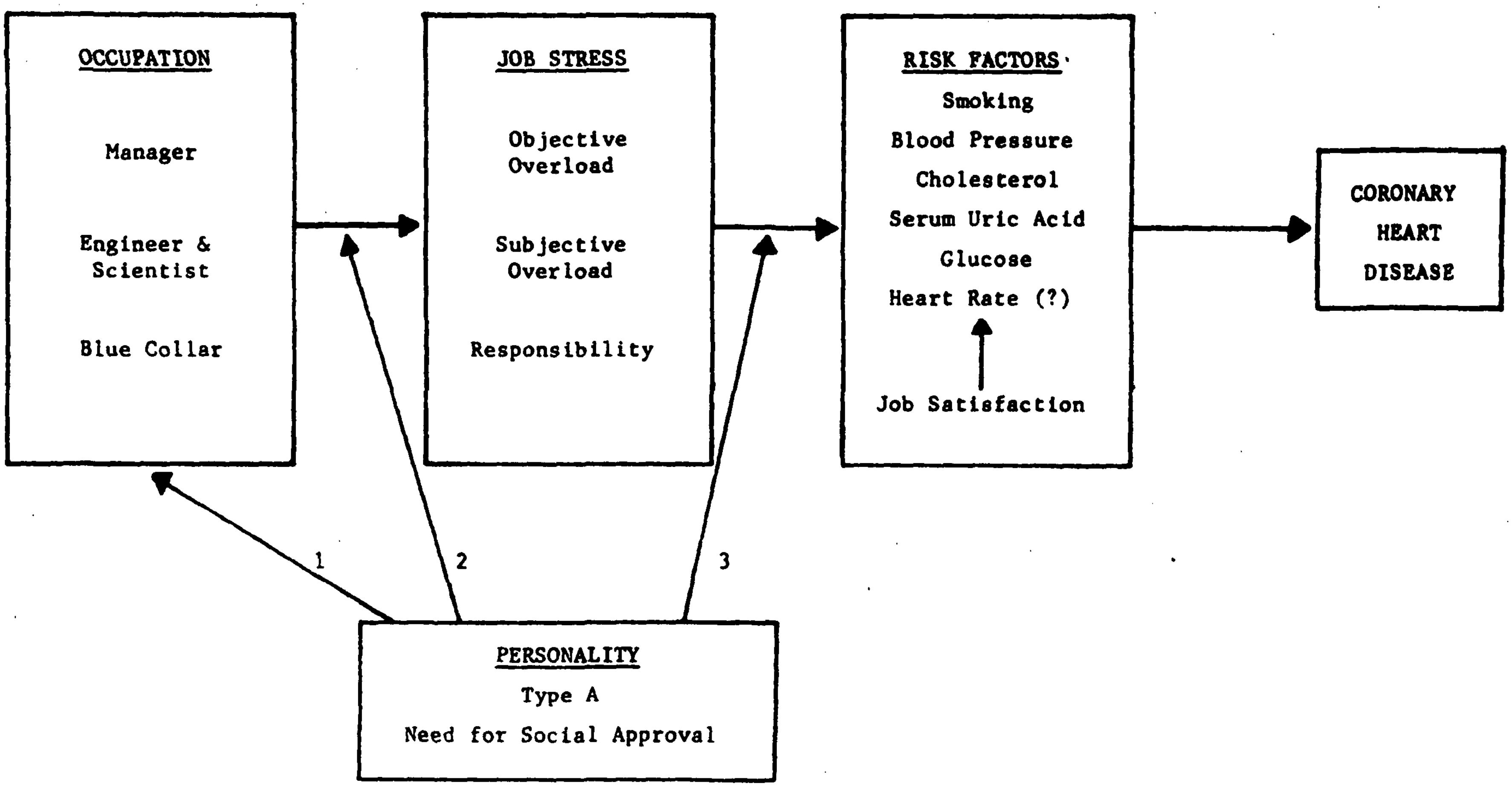
What is called for, then, is a more sophisticated and refined look at the job environment and all of the forces that act upon the individual which may lead to certain breakdowns in his natural functions--and perhaps to illness and death.

This report of our research for NASA presents some of the more specific psychosocial factors related to heart disease. Our basic approach in carrying out this research is depicted in Diagram A on the following page. The horizontal arrows represent hypothesized causal relations. We assume that coronary heart disease, represented in the box on the right of the diagram, is caused by several factors which act upon and influence one another in a variety of ways.

We know from a wealth of medical research that there are certain well-known risk factors, closely tied in with the physiology of the person, which increase his chances of having heart disease. These are represented in the second panel from the right. Smoking, blood pressure, chlesterol, serum uric acid, and glucose have all been suggested as risk factors in heart disease. We have included heart rate, not because it is a well-known risk factor, but because it does show changes under stress. We also include job satisfaction as a risk factor here. Its inclusion is based upon our new findings which we shall discuss shortly.

Further to the left in Diagram A we find the next panel presenting job stresses. We are hypothesizing in this model that certain types of job stresses cause certain changes in the risk factors. Thus, under stress a person may smore more and his blood pressure and chlesterol may go up. In talking about job stress, we must differentiate between objective and subjective stress. Objective overload is stress which actually occurs in the person's external

Diagram A: How could we explain the occupational differences in CHD?



environment. For example, if a man receives too many phone calls and office visits this may constitute one sort of objective overload. Subjective overload, is a stress which exists solely within the individual--it is how much work load he <u>feels</u> he has, how much of a burden or pressure he believes he is under. Our previous research at NASA has shown that it is important to distinguish between these two types of overload. For, although subjective and objective overload are somewhat correlated (that is, people do feel overloaded when they actually have more phone calls than is normal), these two types of overload may have different effects on the risk factors listed in the adjacent panel.

As an example, in a study of twenty-two white collar men at NASA we found that pulse rate was primarily a function of subjective overload while cholesterol level was a function of both subjective and objective overload. To the medical practitioner this means that one must have an understanding of not only the actual work load of the patient, but of his subjective feelings about the work load as well.

Another type of stress which we are considering here is responsibility. Wardwell and Bahnson (1964) have suggested that it isn't mere responsibility which is the crucial stress but responsibility for other individuals--the responsibility one has for the welfare and actions of other human beings. On the other hand, responsibility for non-person-oriented aspects of work such as for budget, equipment, and projects should not increase coronary risk according to the responsibility hypothesis.

Occupation is another major variable included in our model. As we have already noted, there have been many studies published in medical journals which indicate that the incidence of heart disease tends to vary by occupation (see Marks, 1967 for an excellent review of the literature in this area). Our reason for including occupation in the far left panel of Diagram A is to indicate that different occupations may be characterized by different types of stresses. The job of administrator may have one type of responsibility while the job of engineer or scientist may have another type of responsibility. Similarly, we would expect that blue collar jobs also have their unique forms of occupational stress. Each of these different forms of job stress might affect the risk factors in a somewhat different manner. With this type of differentiation we can begin to more specifically explain global differences between occupational groups in incidence of coronary heart disease.

On the following page, Table 1 presents some data which reveal the nature of such occupational differences and their relationship to cardiovascular disease at NASA. These data were gathered from three NASA installations by Jean Mockbee, a statistician from the Occupational Medicine Division at NASA Headquarters.

Looking at the 35-44 year old age group we see that the trade, craft, and technician employees, who are primarily blue collar, have the same prevalence of cardiovascular disease as do managers (2.9%). Further more, their rate of disease is almost six times as high as it is for the engineers and scientists whose prevalence is only .5%. The engineers and scientists have a significantly lower rate of cardiovascular disease. Turning to the 45-54 year old age group, we again see that the engineers and scientists have the lowest prevalence (2.2%) when compared with the managers (5.7%) and the blue collar group of trades employees (3.2%). Mrs. Mockbee informs us that when the data are broken down into five-year rather than ten-year intervals, the findings remain essentially unchanged.

TABLE 1

Occupational Differences in Disease at Three NASA Installations Combined

Prevalence of Disease	Age 35-44			Age 45-54		
	Trade, Craft, Tech.	Manager	Engineer, Scientist	Trade, Craft, Tech.	Manager	Enginee Scienti
Size of Sample	174.0	272.0	598.0	219.0	350.0	537.0
% with Cardiovascular Disease	2.9	2.9	0.5	3.2	5.7	2.2
	n.s.	P=.01		n.s.	P=.02	
		P=.02			n.s.	
% with Hypertension	10.3	8.8	7.9	14.2	13.1	12.7
	n.s.	n.s.		n.s.	n.s.	
		n.s.			n.s.	

Table 1 also presents the prevalence of hypertension for each of these three occupational groups. While the differences between the groups is non-significant, it is interesting to note the trend in both age ranges. The trade, craft, and technician group has the highest prevalence of hypertension (10.3, 14.2), followed by the managers (8.8, 13.1), with the scientists and engineers being lowest (7.9, 12.7).

Now let's turn to another panel in Diagram A, the one at the bottom which refers to the individual's personality. Over the past 15 years a number of studies have been published which suggest that persons with coronary heart disease tend to differ in disposition and temperament from persons who do not have coronary heart disease. These studies have led medical researchers and psychologists to wonder whether or not such personality differences also existed in these individuals prior to the onset of myocardial infarctions and other overt manifestations of coronary heart disease. Perhaps there is a coronary-prone personality.

The most extensive and well-known studies of the coronary-prone personality to date have been carried out by Drs. Friedman, Rosenman, and their colleagues. As part of the Western Collaborative Group Studies they have shown that one can predict coronary heart disease on the basis of the Type A behavior pattern. The Type A personality (as contrasted to Type B) is characterized as hard-driving, ambitious, having a sense of time urgency, upwardly mobile, engaging in multiple activities, being somewhat impatient, being somewhat aggressive or hostile, and tending to prefer job pressure and deadlines.

Friedman, Rosenman et al. have shown that the Type A personality also tends to have elevated serum cholesterol levels, elevated triglycerides and beta-lipoproteins, decreased blood clotting time, elevated daytime excretion of norepinephrine, and capillary ischemia in conjunctival tissue. Such a wealth of findings makes it hard to ignore Type A as a relevant syndrome.[1]

Another personality variable of interest is the need for social approval. Traditionally, measures of this need have been included in psychological research in order to detect the tendency of a person to bias his response to a questionnaire by giving only socially desirable answers.

While we include the measure here for the same reasons, we also have some additional motives. First, we expect that persons high on need for social approval may experience more strain during deadlines and under heavy job pressure. Under such pressures they may feel that the opportunities for them to fail at their work are greater. Furthermore these persons high on need for social approval would feel doubly threatened by failure since it would mean to them that their superiors, colleagues, and subordinates might withhold the social approval and esteem they desire so much. Thus, our second use for this measure is as an indicator of an important need which influences the person's reactions to his social environment.

Another reason for including the measure has derived from some striking findings which suggest that (a) job stress and risk factors correlate with one another quite differently for persons who are high versus persons who are low on the need for social approval, and (b) physiological risk factors correlate with one another quite differently for persons who are high versus persons who are low on the need for social approval. As an example of the latter case, day norepinephrine and day epinephrine were correlated with one another in two groups of employed blue collar men from a company in Michigan. One group of men was high on the need for social approval (as measured by the Crowne-Marlowe scale) while the other group of men was low on the need for social approval.

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[1]The reader is referred to the appendix for a selected bibliography covering this and related studies of risk factors in coronary heart disease.

The correlation between norepinephrine and epinephrine for the group high in need for social approval was -.22 but the correlation between norepinephrine and epinephrine for the group low in this need was +.32. Thus, there is a positive relation in one group and an inverse relation in the other group, and the difference between these two groups is statistically significant. At present, we can make no clear interpretation of what these differences mean, but they certainly are striking and demand further attention.

Referring to Diagram A once more, you will note that we have suggested several channels by which personality variables could lead to coronary heart disease. First of all, on the far left we note arrow Number 1 from personalit to occupation. Personality may influence heart disease via occupational choic For example, the coronary personality may be more likely to seek out the high risk administrative job rather than the job of engineer or scientist. And, perhaps, the coronary personality who finds himself in an engineering job take steps to move into a more administrative job.

Another channel through which personality may have its effect is in mediating the relationship between one's occupation and the stress one experiences in that occupation. This effect is represented by arrow Number 2. To give an illustration, a manager when objectively overloaded may be more likely to experience subjective overload because he is a Type A personality. Similarl Type A scientists may be more likely to experience subjective overload than Type B scientists when objectively overloaded.

A third channel by which personality might have some effect on coronary heart disease is represented by arrow Number 3. While job stress may cause changes in risk factors such as cholesterol and number of cigarettes smoked, such changes are perhaps more likely to occur if the person is Type A rather than Type B. Overall we have a picture of personality as a variable that effec many levels in our hypothesized chain of events leading to coronary heart disease.

For the physician interested in heart disease prevention, one implication of the already available research on heart disease is that it may be just as important to find out about the personality of the individual as it is to find out about his work, how he views his work, and his blood pressure, cholesterol, and glucose levels. Knowledge of the person's standing on all of the variables may allow the physician (or the personnel officer of an organization) to provide additional help and counseling to the person trying to make decisions about future steps in his career development (e.g., should he continue as a manager, or should he change jobs).

If we look back on the more conventional approaches to studying heart disease we find that when one combines information about all the physiological variables plus the Personality Type A, only about twenty percent of the variance in coronary heart disease is accounted for. Eighty percent of variance is still unexplained. Recently, however, we have discovered some new findings relating job satisfaction to coronary heart disease which may account for some of the unexplained variance.

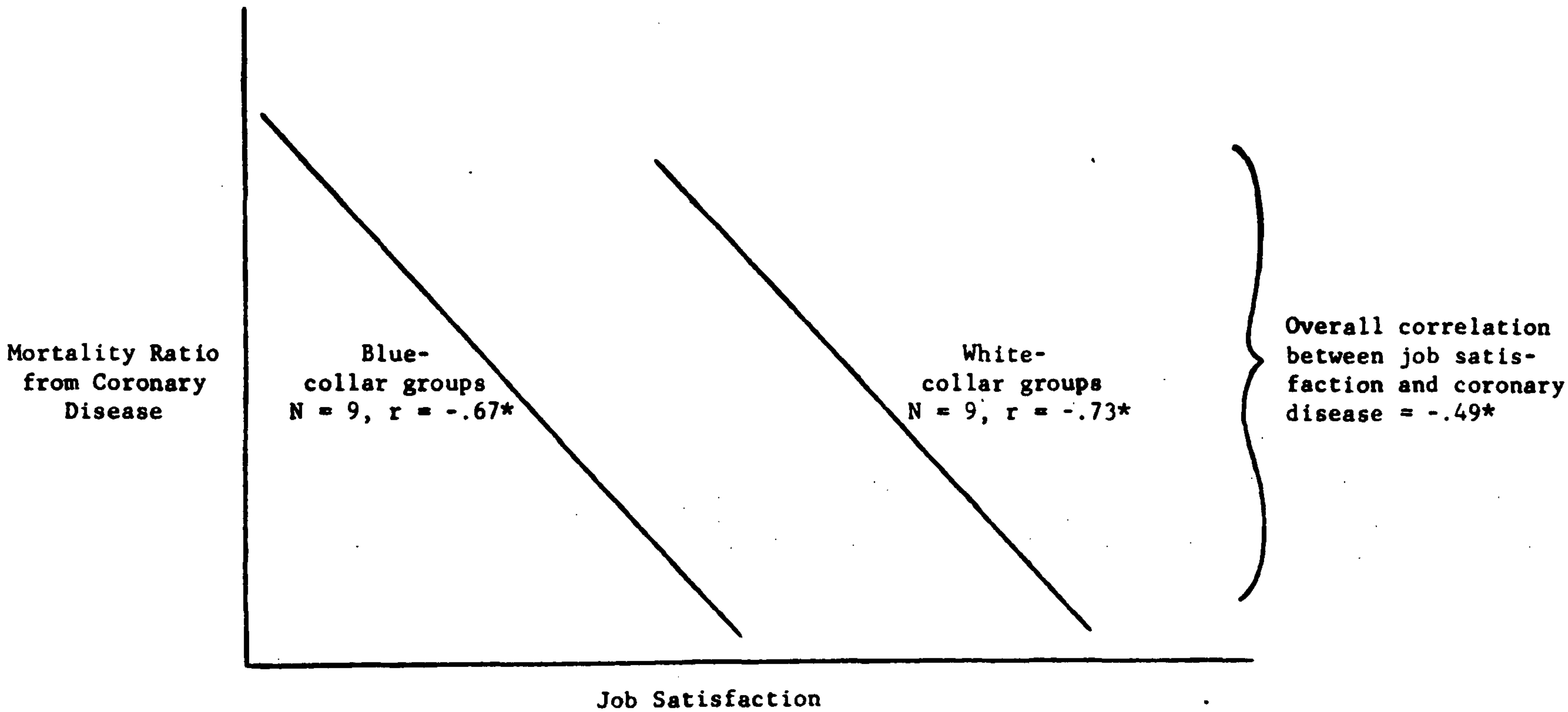
As part of a dissertation carried out by Dr. Stephen Sales, subjects were experimentally subjected to conditions of overload and underload. Pre-experimental and post-experimental blood samples were taken and analyzed for serum cholesterol. One of the findings of the study was that people most dissatisfied with the task showed the highest increases in cholesterol. This suggested that job satisfaction might be related to coronary heart disease.

Support for this relationship between job satisfaction and coronary heart disease was obtained by comparing these two variables across eighteen occupational groups. For each occupation we had a mean job satisfaction score derived from previous studies of job satisfaction in these occupations. We also had for each of these occupations the standard mortality ratio of coronary heart disease. Heart disease was defined as rubric 4200 of the International Classification of Diseases. The latter figures came from Public Health Service statistics. The findings are illustrated in Figure 1 on page 12.

These findings show that job satisfaction and coronary heart disease are correlated - .49 across eighteen occupational groups. Furthermore, the relationship is higher and in the same direction for both the nine blue collar groups and the nine white collar groups (note that the blue collar groups tend to be less satisfied with their jobs, suggesting that their rate of heart disease is higher). Of course, these correlations are based on aggregate statistics and are presumably larger than the parallel correlations for individuals might be.

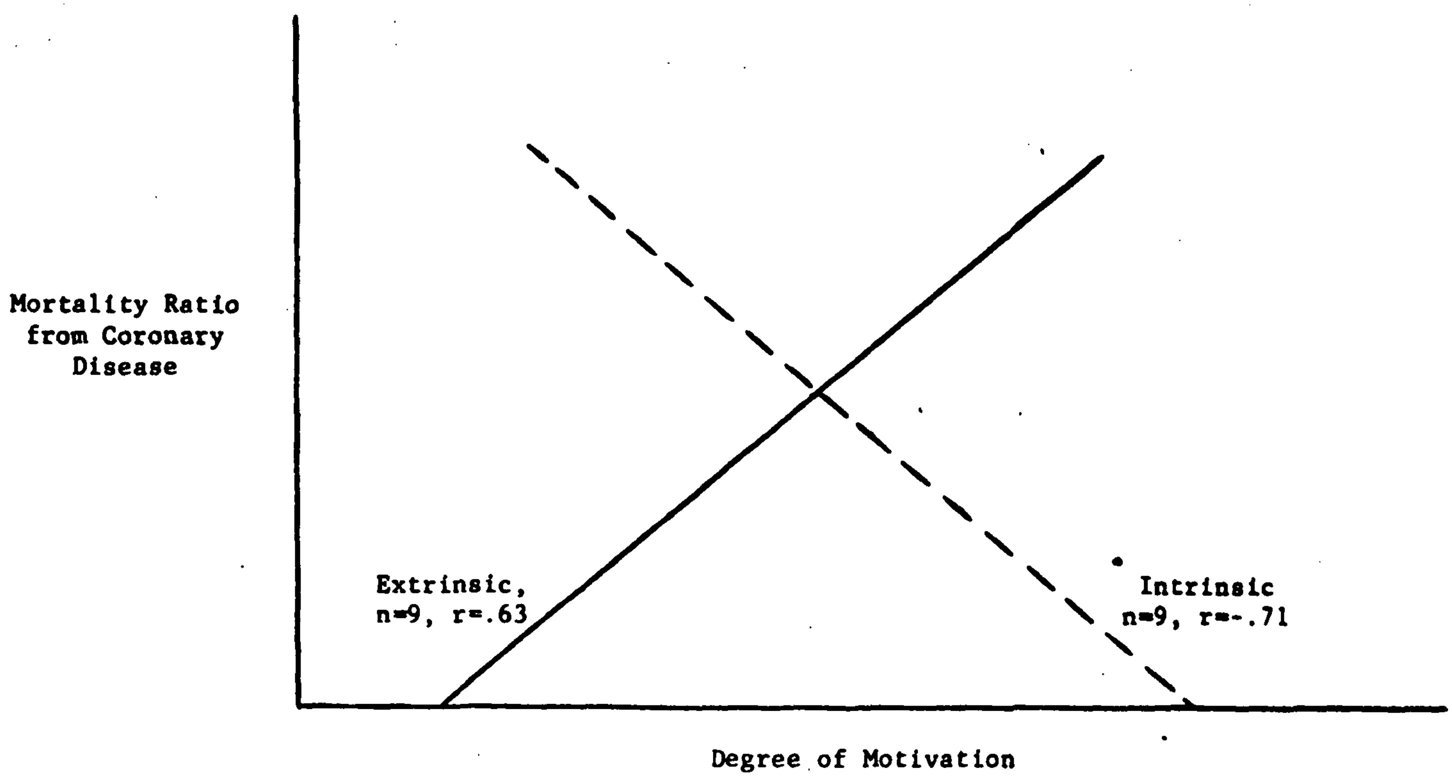
Some additional research, using the same heart disease data, has been carried out by James House from the Univeristy of Michigan. His findings suggest that the type of motivation one has for working may be related to the risk of developing coronary heart disease. These latter findings are based on nine occupational groups and are illustrated in Figure 2 on page 13. The data show that the more the members of an occupational group are motivated to work for extrinsic rewards, such as for pay and prestige, the higher is that group's mortality ratio for coronary heart disease ($r = .63$). This relationship between extrinsic motivation and coronary heart disease rate is represented by the solid line in the figure. Intrinsic motivation, however, is inversely related to coronary heart disease. The higher the motivation to work for intrinsic rewards

Figure 1: Relationship between job satisfaction and rates of coronary deaths (Rubric 420.0) in eighteen groups of employed men.



* $p < .05$

Figure 2: Relationship between motivation and rates of coronary deaths in nine groups of employed men.



such as for the enjoyment one gets out of the work itself, the lower the standard mortality ratio for coronary heart disease (r = -.71). These findings are impressive in the sense that they account for roughly thirty-six to forty-nine percent of the variance in mortality ratios. They are especially relevant to occupational medicine since the findings link motives to work with coronary heart disease.[2]

Now let us turn to our current project at Goddard Space Flight Center. The main purpose of this project is to explain the fact, already presented in Table 1, that managers have higher rates of cardiovascular disease than do engineers and scientists. Our general strategy will be to describe the research methods used in our most recent studies and then present the results. Finally, we shall discuss some implications of our findings for preventive medical programs.

Method

Sample

Three occupational groups of male employees from Goddard Space Flight Center--administrators, engineers, and scientists--were selected for the study. A person was initially defined as being a member of one of these three groups according to his job title in the personnel rosters of Goddard.

Next, administrators and engineers were each divided up into two additional groups. These groups were as follows:

a) Administrators in administrative environments

b) Administrators in engineering environments

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[2]We are currently carrying out studies of the relationships of extrinsic and intrinsic satisfaction to coronary heart disease. The findings are similar to those for extrinsic and intrinsic motivation although it appears that there are slightly different relationships between these satisfactions and heart disease for blue collar as compared to white collar workers.

c) Engineers in engineering environments

d) Engineers in administrative environments

This breakdown was made in order to study potential fit and misfit between a person's job and the person's job environment. Where the job was similar to the job environment, as in (a) and (c) above, we said that a potential fit might be present. Where the job was different from the job environment, as in (b) and (d) above, we said that potential misfit might be present. We would then see whether the potential fit groups would report lower job stress and lower levels of cholesterol and other coronary heart disease risk factors than the potential misfit groups.

Since we formed these subgroups before actually determining the work environment of the person, we used the following definition of job environment. We defined an administrative environment as that environment where, according to the personnel records of Goddard, there existed the highest ratio of administrators to engineers using the division as the unit of environment. Likewise, we defined the engineering environment as the environment where there existed the highest ratio of engineers to administrators.

While we could find no scientists working in either administrative or engineering environments, we included the scientists in the study because of their NASA record of low rates of coronary heart disease, smoking, obesity, job absence, and other potential risk factors in heart disease.

Thus, we ended up with five groups for study: two groups of administrators, two groups of engineers, and the scientists. Our next step was to randomly sample out seventy men in each of the five groups to form a pool of potential volunteers for the study. Letters were then sent out to these 350 men informing them of the study and indicating that our laboratory assistant from The University of Michigan would probably be contacting them to see if they wished to participate.

Our assistant, a young attractive female in her early twenties, then visited 285 of these men in their offices asking them if they would be willing to participate in the study which required a blood sample of them, measures of blood pressure and pulse rate, and the filling out of a lengthy questionnaire. If the person agreed to volunteer, two readings of diastolic and systolic blood pressure and two readings of pulse rate were obtained. Then 30 cc.'s of blood were drawn. The volunteer was then handed the questionnaire and told to complete it as quickly as possible and return it to The University of Michigan by mail in the enclosed stamped, pre-addressed envelope. Eighty-nine percent of those contacted agreed to participate in the study. The average age of the men who participated was forty-years old with two-thirds of the group falling between thirty-four and forty-seven years of age. Eighty-three percent of those who volunteered returned the questionnaire. Thus, we have physiological data on 253 men and questionnaire data on 211 of those volunteers.

An option for all volunteers was to further participate by having their secretaries keep a tally of their phone calls, office visits, and meetings. This would be hopefully continued on an hourly basis for three days. Our preliminary interviews and pretests at Goddard had led us to believe that while many employees did not have their own secretaries, there was a possibility that some volunteers who did have such resources would use them in our study. Twenty-five men did agree to have such tallies taken. These men come almost exclusively from the subgroup of administrators in administration. We shall have more to say about them later.

The blood that was drawn in each volunteer's office was immediately spun to serum and frozen for subsequent shipment to The University of Michigan's Institute for Social Research. There, it was thawed and a number of analyses were carried out (cholesterol, serum uric acid, casual glucose, etc.) in a modern laboratory using automated and highly controlled analysis equipment such as the Auto-Analyzer.

The questionnaires were then coded, and all data were transferred to magnetic tape for analyses on the computer facilities of the Institute. We shall now turn to some of the results of these analyses.

Results

The findings that will now be reported should be considered preliminary because our analyses are not yet completed. First, we shall present results which bear on previous NASA findings relating overload to physiological measures of stress. Then, we shall present some of our preliminary work on personality variables which may relate to coronary heart disease. Finally, we shall consider some of the data which relate to differences between administrators, scientists, and engineers in the current study.

As already noted, in our earlier study of twenty-two men at NASA Headquarters, we found that objective work load as measured by the number of phone calls and office visits a person had per hour was positively correlated with subjective quantitative work load ($r = .64$). We then went on to relate these measures of objective and subjective work load to our physiological variables, pulse rate and serum cholesterol level. Pulse rate and cholesterol level were unrelated. We found that pulse rate was primarily related to subjective quantitative overload rather than to objective work load ($r = .68$). We further found that cholesterol was related to both objective and subjective work load ($r = .43$ and $r = .41$, respectively). In the current study we have measures of these same variables.

Objective quantitative overload has been measured in a similar way as in our earlier study. We have determined for each of the twenty-five persons on whom we have work tallies, the number of phone calls, office visits, and meetings they had per hour. Unlike the previous study, we find no correlation between this measure of objective work load and our same measure of subjective work load ($r = .02$, n.s.). This finding suggests that perhaps one's subjective impression regarding work load is more independent of the actual amount of work load than we had previously thought. We must, however, use caution in interpreting this finding since there are other measures of objective and subjective work load which do relate to one another. We shall discuss these measures shortly.

In the present study we also find that pulse rate does not correlate with objective or subjective quantitative work load although it was expected to do so ($r = .17$, n.s.; and $r = .04$, n.s., respectively). Serum cholesterol level also fails to correlate with these objective and subjective measures of work load ($r = -.30$, n.s.; and $r = .01$, n.s., respectively). Pulse rate and cholesterol are unrelated as in our previous study ($r = .14$, n.s.).

This failure to replicate our previous findings leads us to believe that the analyses may not have uncovered certain moderator variables which are important in distinguishing between the characteristics of the earlier sample from NASA Headquarters and the present sample of men from Goddard. For one thing, we may have a serious sampling problem regarding our measure of objective work load. In the Headquarters study, ninety-six percent of the men contacted agreed to have a tally made of their work. In this study less than ten percent contacted agreed. Thus, the data relating to objective overload measures should be treated with caution.

Second, our method of obtaining pulse rate in these two studies has been markedly different. In the study of the twenty-two Headquarters men, pulse rate was based on averages taken over three-hour periods. In the present study, thirty second samples were taken two times within a minute or so of one another as an estimate of pulse rate. Since pulse rate is highly labile, it is conceivable that we were measuring some reaction to the test situation rather than some sample of pulse rate on the job. This suggests that we may have to return, in future studies, to the more careful measuring of pulse using our telemetry equipment.

At present we are still exploring some hypotheses about the failure of cholesterol to relate to our overload measures. These hypotheses include possibilities that seasonal variation may serve to attenuate certain relationships between cholesterol and subjective and objective quantitative work load. We have data from Goddard health examinations which show striking changes in cholesterol over the twelve months of the year with peaks in cholesterol value during November through January and troughs in March through July. The difference between peaks and troughs was 42 mg./100 ml. The present study was carried out in April and May. The previous study was carried out in June through August.

While our findings on cholesterol and pulse rate are negative so far, we do have some interesting positive findings to present with regard to cigarette smoking, a well-known risk factor in coronary heart disease. We turn to these findings in the section that follows.

Cigarette Smoking

Cigarette smoking has been one of the much publicized risk factors in coronary heart disease. In our study at Goddard, we asked persons to indicate the actual number of cigarettes they typically smoke in a day. The participants in the study who do smoke report smoking an average of twenty-four cigarettes per day. The data which we shall now present are for only those persons who smoke one or more cigarettes per day. Those who smoke no cigarettes are excluded since they would skew the distributions if included.

Some interesting results present themselves when we compare the persons who had their secretaries keep a tally of their work load with those persons who did not have a secretary keep a tally. Specifically, forty-four out of 189 or twenty-three percent of the non-tally volunteers returning the questionnaire smoke. By contrast, eleven out of twenty-five or forty-four percent of the volunteers who had secretaries keeping tallies for them smoke. The differences in the proportions of persons who smoke in these two groups are statistically significant ($x^2 = 3.94$, $p < .05$). But, why the striking difference?

Earlier we noted that most of the volunteers for the tally part of the study are administrators. Perhaps administrators smoke more. While administrators tend to smoke more than engineers and scientists, the differences are minimal ($x^2 = 2.77$, n.s.).

Another possibility is that tally volunteers, having secretaries, also have higher formal status with its accompanying responsibilities than do non-tally volunteers. While this may be so, we find that formal status as measured by G.S. level and salary, shows no relationship to the number of cigarettes a person smokes. Therefore, it must not be formal status which accounts for these differences in smoking among tally and non-tally volunteers.

With regard to responsibilities, however, we find quite a different picture. On page 21, Table 2 presents the average percent of time tally and non-tally volunteers report spending in various responsibilities. We see here that on three of the responsibilities there are significant differences between the two groups. Tally volunteers report spending 40.2 percent of their time being responsible for the work of others while non-tally volunteers report that this

TABLE 2

Mean Percent of Time Spent Carrying Out Various Responsibilities by Tally and Non-tally Volunteers

Type of Responsibility	Volunteer		
	Tally	Non-tally	p <
Work of others	40.2	27.4	.01
Other's futures	15.6	7.0	.001
Money	11.8	9.6	n.s.
Equipment	3.6	9.1	.05
Projects	29.2	51.6	n.s.

responsibility takes up on the average only 27.4 percent of their time. This difference is significant at the .01 level. Tally volunteers also spend over twice as much time in responsibilities having to do with others' futures as do the non-tally volunteers: 15.6 percent compared to 7.0 percent. This difference is significant at the .001 level. While both tally and non-tally persons spend less than ten percent of their time on responsibilities for equipment the tally persons do spend significantly less time: 3.6 percent of the time as compared to 9.1 percent of the time. These findings are interesting in light of the responsibility hypothesis we mentioned earlier. The hypothesis predicts that person-oriented responsibilities such as for another person's work and future should be related to heart disease while object-oriented responsibilities such as for budgets, equipment, etc., should be unrelated to heart disease.

Now the crucial question is do any of these responsibilities on which these two groups differ also relate to cigarette smoking? When we look at the data in Table 3 (page 23), we find that this is indeed the case. The percent of time spent carrying out responsibility for the work of others correlates .31 ($p < .05$) with number of cigarettes smoked. The percent of time spend in responsibility for others' futures correlates non-significantly but in a positive direction, .08. Responsibility for money, equipment, and projects also correlates non-significantly but negatively with number of cigarettes smoked.

Overall, the set of findings suggest that the reason the tally volunteers smoke more is because they have more person-related responsibilities than the non-tally persons. Whether having more of these types of responsibilities makes one tend to volunteer more often for such tallies remains to be seen. Perhaps, having a secretary who can observe one's activities for three days is a luxury

TABLE 3

Correlation between Percent of Time Spent in Various Responsibilities and Number of Cigarettes Smoked*

Responsibility for	r
Work of others	.31**
Others' futures	.08
Money	-.22
Equipment	-.19
Projects	-.08

* for persons smoking 1 or more cigarettes per day.

** $p < .05$

provided to persons with more of the types of responsibilities we have just been describing.

Another preliminary interpretation of these findings is that persons who do smoke do tend to volunteer for more activities. This interpretation is consistent with the notion that persons who smoke are also persons who seek stimulation or arousal, smoking being an oral form of such arousal. Indeed, studies of college students who volunteer for psychology experiments show that the volunteers score higher on measures of arousal-seeking than non-volunteers and that arousal-seeking is a central factor in tobacco smoking among college students (Schubert, 1964, 1965). Such persons could be expected to take on more activities, perhaps even overload themselves intentionally to provide more stimulus inputs from their work environment. It is also possible that smoking could act as a stimulant arousing the person to seek out even more stimuli and work.

We cannot tell with the present data whether cigarette smokers are more likely to overburden themselves with work as part of the same arousal-seeking behavior that causes them to smoke or whether smoking causes them to seek arousal and in the process overburden themselves. Nevertheless, we do have additional data which show that persons who smoke more seem to be more overloaded in their work.

Using data drawn from the tallies kept by the secretaries, we find that objective quantitative overload and number of cigarettes smoked for persons smoking one or more cigarettes per day are positively related ($r = .58$, $p < .05$). In other words, persons with more phone calls, office visits, and meetings per given unit of work time also smoke more cigarettes than persons with fewer phone calls, office visits, and meetings per given unit of work time.

Cigarette smoking also correlates positively with the person's report of a tendency toward environmental overburdening ($r = .36$, $p < .01$). Environmental burdening is a cluster developed in earlier research carried out by Stephen Sales as part of a study aimed at developing a personality measure of behavior Type A. Sales defines environmental burdening in his cluster of items as:

> "The reported presence of the subject in an environment in which he experiences chronic objective quantitative overload. Reported exposure of the subject to constant deadlines, deadline pressures, and job responsibility."

In other words, the environmental overburdening cluster from the Sales measure of Type A is a measure of subjective quantitative overload. In fact, environmental overburdening correlates .44 ($p < .01$) with our subjective quantitative overload factor.

Another interesting characteristic of smokers is that they score high on a cluster which measures the extent to which they feel impatient about the extent to which their profession and NASA is advancing knowledge and accomplishing goals. Typical items in measuring "impatience with advancement of the profession" express dissatisfaction with statements such as (a) The <u>rate</u> at which technological developments are occurring in your field. (b) The <u>pace</u> at which the profession, field, or area is developing. Persons who feel that the rate or pace is very little smoke more than those who feel the pace is great ($r = -.32$, $p < .05$). One explanation for this relationship might go as follows: (a) we have already suggested that smoking is symptomatic of arousal-seeking behavior; (b) arousal-seekers are persons who tend to perceive their environment as less stimulating than they want it to be--therefore, they seek arousal. (c) Consistent with this perceptual bias is their view of the rate at which the profession is developing. Things are not happening as fast as they should in their view, and thus, those who smoke more also report greater impatience with the rate of technological and professional development in their field.

Another finding of interest is the relationship between number of cigarettes smoked and number of reported visits to the health dispensary on the base. These two variables are inversely related ($r = -.31$, $p < .05$). That is, the more people smoke, the less often they visit the dispensary. There are a number of possible interpretations we can make about this finding. First of all, smokers may be less concerned about their health than non-smokers. Thus, they not only smoke, but they also make little use of health facilities, They may show less hypochondriasis than non-smokers which accounts for their low frequency of illness behavior. Second, smokers may not visit the dispensary as often because they are already subjectively as well as objectively overloaded with work. In fact, we have just presented evidence which supports this explanation. And, of course, both explanations may jointly account for the results just presented.

While dispensary visits and cigarette smoking are negatively related, volunteering for yearly NASA health examinations and cigarette smoking are unrelated ($F = .19$, n.s.). Why there should be this difference in findings regarding these two types of illness behavior is not clear, but they are worth noting since physicians frequently derive health statistics on smoking in their patient population from both dispensary visits and from voluntary yearly examinations.

Finally, we find that smoking is also correlated with pulse rate ($r = .35$, $p < .05$) and with systolic blood pressure ($r = .32$, $p < .05$).

What, then, is the overall profile that we get of the heavy cigarette smoker? The findings we have just discussed are summarized in Figure 3 on the following page. They provide a picture of a person who tends to

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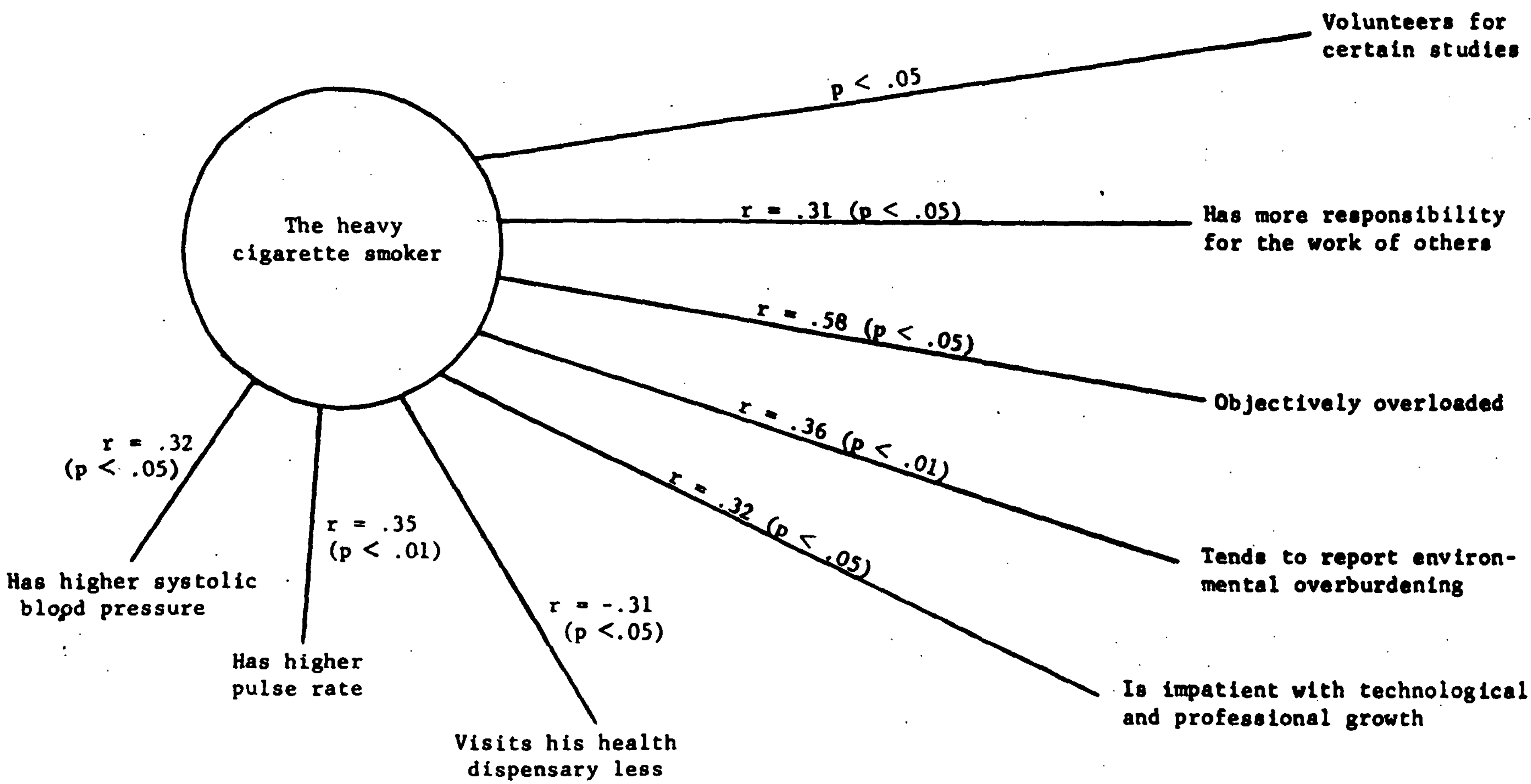

Figure 3: A profile of the cigarette smoker.

volunteer for certain activities -- a step towards more overload. Furthermore, the heavy smoker is more likely to be objectively overloaded and tends to characterize himself as being environmentally overburdened. He has more responsibility for the work of others, and he is impatient with the rate at which technological growth and the growth of his profession is proceeding. Perhaps ironically, while he visits his health dispensary less, he may be in poorer health having higher systolic blood pressure and higher pulse rate.

Some Differences between Administrators, Engineers, and Scientists

Now let's turn to some data which bear on one of the central goals of our research. Namely, to account for the occupational differences in coronary heart disease which have been noted by Dr. Carlos Villafana and Mrs. Mockbee among administrators, engineers, and scientists. In Table 4 (page 29) we find a summary of some early findings on these three occupational groups. We have defined occupation here in terms of what the Goddard volunteer labeled himself on the questionnaire.

First of all, we note that as one moves from administrators to scientists, one finds significant decreases in average age ($p < .001$). The administrators average about forty-four years old while the engineers have an average age of thirty-nine. The scientists average slightly over thirty-five years of age. Since we already know that coronary heart disease appears more often in older individuals, it will be important to control on age where we feel that it is related to certain of our dependent variables such as serum chlesterol level. Surely, one could argue that administrators have a higher incidence of cardiovascular disease and hypertension on the basis of age alone unless one could control on that variable while searching for other differences.

TABLE 4

Occupational Differences in Certain Background, Health, and Job Stress Variables

Measures	Occupation			
	Administrator	Engineer	Scientist	p
Age	44.4	39.0	35.6	.001
Average schooling	completed college	some grad. school	masters	.001
% participate in annual NASA health exams	71.0	59.0	26.0	.001
# cigarettes smoked[1]	31.6	18.8	19.9	.05
% smokers	33.0	22.0	21.0	n.s.
Systolic blood pressure	134.8	128.6	131.3	.05[2]
Subjective quantitative overload cluster	3.7[3]	3.4	3.1	.001
Days elapsed until questionnaire returned	19.9	13.1	14.5	.05
Subjective qualitative overload factor	1.8	2.0	2.1	.05
Opportunity to use administrative skills	3.6	3.0	2.6	.001
Opportunity to use one's education, talents, and abilities	3.3	3.2	3.8	.001
Role conflict	2.2	2.1	1.9	.05

[1] For persons smoking one or more cigarettes per day.

[2] Significant when corrected for age differences.

[3] These values are based on a five-point rating scale where 1 = "very little" and 5 = "very great."

The next row in Table 4 shows that there is a significant increase in level of education as one moves from administrators to engineers to scientists ($p < .001$). Administrators on the average complete college or undergraduate school. Engineers tend to have some graduate school work, while scientists average a masters degree. Education may be a relevant variable in the study of coronary heart disease. For one thing, we can theoretically suggest that education provides an opportunity for a person to learn effective modes for coping with both quantitative and qualitative overload. Experience in colleges and universities has often been noted as providing skills and practice in handling many complex situations. Such training could provide a person with coping skills for dealing with role conflict on the job. A recent study by Hinkle and his colleagues (1968) at Bell Telephone provides some support for this hypothesis: They found in a three-year study of 1,160 male employees that myocardial infarctions were twice as prevalent among non-college educated men compared to college men. All other causes of death were evenly distributed among the two groups.

Next in Table 4 we see that 71% of the administrators, 59% of the engineers, and only 26% of the scientists participate in annual NASA health examinations. The differences in participation rates should be of interest to persons using the medical examinations to derive some estimates of prevalence of various coronary conditions. Data drawn from such examinations may be most valid for describing the general health conditions of the administrators but could be misleading in describing the health conditions of the scientists. Perhaps only the healthiest of the scientists participate (which would provide a picture of the scientists which would underestimate the amount of obesity, silent heart pathologies, etc.). Since the volunteer rate among scientists is much higher for this study than it is for the health examination, we will be able to make some comparisons on variables like smoking, obesity, and hypertension to see whether data derived from the yearly health examinations under-, over-, or correctly estimate the prevalence of some of these risk factors.

Continuing, we see that among those who smoke, administrators are heavier smokers than are engineers and scientists (31.6 cigarettes per day compared to 18.8 and 19.9 respectively). There are also a greater percentage of smokers among the administrators than among the engineers and scientists, although the differences are not significant.

With regard to systolic blood pressure, the administrators again score higher than the engineers and the scientists (134.8, 128.6, and 131.3 respectively for the three groups). The difference across the three groups is significant ($p < .05$) when we correct for age differences between the three groups.

What about overload? How do these three occupational groups differ with regard to this variable which has often been implicated as a risk factor in heart disease? First of all, we see that administrators report being more subjectively overloaded than engineers and than scientists. The scientists are the least overloaded of all. The type of overload we are talking about here is subjective quantitative overload--too much work to do given the amount of time to do it in. The items in this measure are quite similar to the items in our subjective quantitative overload factor which we derived from a study of overload in university professors. In fact the subjective quantitative overload cluster we are using here correlates quite highly with the subjective quantitative overload factor from that previous study ($r = .66$, $p < .001$).

We get some additional insight into the nature of overload for the administrators and the other two groups when we look at how long it took each occupational group to complete and send in the questionnaire they were given for this study. Almost twenty days elapsed on the average until questionnaires were received back from administrators compared to slightly over thirteen days for the engineers and 14.5 days for the scientists. The differences in elapsed time across the three groups is significant ($p < .05$) and suggest that administrators are objectively as well as subjectively overloaded.

Now let's turn to qualitative overload. Here the picture is quite different. It is the scientists who report the most qualitative overload followed by the engineers, and then the administrators. Thus, with regard to the types of subjectively felt overload reported by different occupations, it appears that administrators suffer more from quantitative overload while scientists suffer more from qualitative overload. These findings are consistent with some earlier work on university professors and university administrators carried out here at the Institute for Social Research. In that study (French, Tupper, & Mueller, 1965) the professors (who seem analogous to our scientists) reported feeling low self-esteem due to the qualitatively overloading aspects of their work--it was important to do a professionally high quality job even if it took some time to complete it. The university administrators, on the other hand, reported feeling low self-esteem not from qualitative overload but from quantitative overload--they couldn't hope to do the best job on everything, but they were expected to handle a certain quantity of work in a given time. Perhaps we shall find that other types of job overload only constitute sources of stress for one occupational group but not for another.

Continuing down Table 4, we notice that administrators report more opportunity to use their administrative skills. Engineers report less opportunity, and scientists report the least opportunity. The fact that administrators do have more opportunity could suggest that they also have greater chances to become involved in role conflicts with other individuals. We note in the last line of Table 4 that administrators do tend to report more role conflict, followed by engineers, with scientists reporting the least amount of role conflict. The differences across the three groups are significant, and are supportive of some potentially stressful outcomes which would derive from having a lot of opportunity to use one's administrative skills.

Finally, we note that while administrators have the most opportunity to use their administrative skills, they report less opportunity to use their education, talents, and abilities than do the scientists. Both they and the engineers report being under-utilized, while the scientists report having the most opportunity to utilize all of their skills, abilities, and education.

To summarize the picture at this point, we get a view of the administrator as older, less educated, quantitatively more overloaded, and more likely to experience role conflict than the scientist. The administrator also smokes more and has a higher systolic blood pressure than the scientist. The scientist, on the other hand, is better educated, qualitatively more overloaded, and is less likely to get into role conflict. The scientist also smokes less and has lower systolic blood pressure. The engineer falls somewhere between these two occupational groups.

What About Responsibility?

We have already noted that responsibility for the work of others is correlated with number of cigarettes smoked. Do the three occupational groups differ in terms of the amount and types of responsibilities they report? Table 5 (page 34) presents data on the three occupations which helps us answer these questions.

First of all we see that an index of the overall amount of responsibility

TABLE 5

Occupational Differences in Responsibility

Measure	Occupation			
	Administrator	Engineer	Scientist	p
Amount of responsibilities index	3.4	3.0	2.9	.01
% time carrying out responsibility for:				
a) others' work	42.9	27.1	17.1	.001
b) others' futures	12.1	6.3	6.7	.01
c) money	11.2	10.8	6.5	.05
d) equipment	4.4	9.3	12.0	.05
e) projects	29.6	46.6	72.2	.01

reported differs significantly across the three occupations ($p < .01$). Administrators report the most responsibility, followed by engineers, with scientists reporting the least.

Now let's look at the more specific types of responsibility. Administrators spend about 42% of their time carrying out responsibilities for others' work while engineers spend only about 27% of their time doing so, and scientists spend only about 17% of their time doing so. The difference across these three groups is quite significant ($p < .001$). Similarly administrators spend the most time of the three groups on responsibilities for others' futures--almost twice as much time as do the engineers and scientists (12.1% versus 6.3% and 6.7% respectively). Thus, with regard to the two responsibilities for people, which we have already labeled as reflecting the "responsibility hypothesis" in coronary heart disease, the administrators report spending the greatest amount of time on the average.

With regard to responsibilities for money, administrators spend slightly more time on the average than do engineers. The scientists spend the least time of all three groups on this responsibility.

The pattern, however, is reversed with regard to responsibility for equipment and projects. Here the scientists spend the most amount of time compared to the administrators and engineers. In fact, the scientists and engineers spend, on the average, the greatest segments of their time carrying out responsibilities which should not be associated with coronary heart disease. The scientists spend 72.2% of their time in responsibility for projects while the engineers spend 46.6% of their time (and administrators spend 29.6% of their time in responsibility for projects). On the other hand, the largest segment of time for the administrators is spent carrying out responsibilities for the work of others--a responsibility which should be associated with coronary heart disease according to the responsibility hypothesis.

With regard to responsibilities then, the administrators report more of them overall, and they also report more responsibilities which are people-oriented than do the engineers and scientists. The engineers and scientists report more object-oriented responsibilities than do the administrators.

Personality Differences between the Three Occupations

Now let's turn to Table 6 (page 37) which presents some measures of personality on which the three occupational groups differ. First of all, we see that the administrators appear to score lower on a measure of rigid personality, while engineers fall in the middle and scientists score highest. This measure is a scale from the California Personality Inventory which characterizes a person who is unwilling to give in to other persons' points of view, and is inflexible when it comes to comprising his own needs to meet someone elses.

This measure of personality is of interest because of some previous work done in a nationwide study of role conflict which linked such conflict to the rigid personality (Kahn et al., 1964). Kahn and his colleagues found that persons who were placed in objective role conflicts were less likely to report feeling that a conflict was present if they were rigid personalities. On the other hand, if they were flexible personalities, they were more likely to feel the presence of the conflict. The explanation given was the flexible person always bending with the wind, put himself into more conflicts by attempting to cope with all points of view by meeting them simultaneously. The rigid person, on the other hand, would shut himself off from the conflict perhaps by ignoring its existence, and thus avoid the discomfort of feeling that a

TABLE 6

Occupational Differences in Personality

Measure	Occupation			
	Administrator	Engineer	Scientist	p
Rigid personality (Flex.-rigid. scale)	2.3[1]	2.4	2.5	.01
Involved striving	5.2[2]	4.8	5.0	.05
Positive attitude toward pressure	5.2	4.9	4.8	.05
Environmental overburdening	5.6	5.1	5.4	.05
Leadership	5.0	4.3	4.2	.05
What I Am Like (Type A)	3.5	3.3	3.2	.05

[1] These values are based on a four-point scale where 1 = low rigid and 4 = high rigid.

[2] These values are based on a seven-point scale where 1 = low on the personality trait and 7 = high on the personality trait.

conflict really existed. As we have already noted, the administrators tend to report more role conflict than do the engineers and scientists. Perhaps this is because the administrators are more flexible and thus set themselves up for such conflict.

The next five personality dimensions in Table 6 were all designed to measure the Type A coronary-prone personality. On all of them the administrators score the highest. Administrators seem to see themselves as higher on involved striving in what they do, higher on liking pressure and perhaps seeking it out, and higher on tending to become overburdened (this personality measure, as we have noted is positively correlated with number of cigarettes smoked) than do engineers and scientists. They also score higher on leadership, a dimension which could be looked at as a tendency to take over positions of responsibility for the welfare and work of others. Finally, there is a significant tendency for administrators to score highest on a three-item measure of Type A called "What I Am Like." This measure, correlates .80 with the Jenkins Activity Scale, a validated measure used to predict to Type A personality (Jenkins, 1967).

In summary, then, we see that the administrators, compared to the engineers and scientists, tend to suffer more quantitative overload but less qualitative overload; and they also appear to be under more stress from responsibilities for people, but they have less responsibility for projects and equipment. Furthermore, they also seem to have more of the personality characteristics which typify the Type A coronary-prone personality. The scientists generally tend to be lowest on these potential risk factors while the engineers are somewhat intermediate.

A Brief Look at Person-environment Fit

Before concluding our presentation of data, let's turn to the notion of poor person-environment fit as a factor which could lead to coronary heart disease. We noted earlier that we had divided the administrators and the engineers into two further groups. These are administrators in administrative environments, administrators in engineering environments, engineers in engineering environments, and engineers in administrative environments. The first and third categories were labeled examples of good fit; and second and fourth categories were called examples of potentially poor fit.

We now have some preliminary data which suggest that poor fit may affect a person's health. Table 7 (page 40) presents data on the relationships between job environment and blood pressure for administrators. We assume that an administrator is better fitted to an organizational unit which is primarily administrative in mission and climate but he is less well fitted to an engineering unit where most of the other personnel are engineers. To obtain a measure of environment in this case, we asked the respondent to estimate what percent of his environment was administrative and what percent was engineering. Environment was defined as follows:

> "Aside from your immediate job, your work life may be affected by the wider environment of your section, branch, division, or directorate. As far as it affects your job, is this wider environment mostly administration, engineering, or science? Considering the mission, the people, and the organizational climate my organizational environment is: . . ." (p. 29, questionnaire).

Table 7 shows that the higher the percent of environment characterized as administrative in nature, the lower both the systolic and diastolic blood pressures tended to be. Thus, good fit as defined here is related to low systolic and diastolic blood pressure ($r = -.38$, p .01; and $r = -.28$, p .01 respectively). Similarly, the higher the percent environment characterized as

TABLE 7

Relationships between Job Environment and Blood Pressure for Administrators

Environment	Blood Pressure	
	SBP	DBP
% Administration	-.38	-.28
% Engineering	.28	.27

F

engineering the higher the blood pressure. Thus, poor fit for administrators associated with high systolic and diastolic blood pressure ($r = .28$, $p < .01$; and $r = .27$, $p < .01$ respectively).

Interestingly enough, this lack of fit does not serve as a source of stress for the engineers. The correlations between percent environment, either engineering or administrative, and blood pressure are close to zero and non-significant. This lack of correlation for the engineers, but its presence for the administrators, suggests that certain types of poor fit may serve as a source of stress for one occupational group but not for another. In our continuing analyses we shall be looking for other types of stresses which may affect one occupational group but not the other.

Discussion

In Diagram A we presented a model of coronary heart disease which implied that personality, type of occupation, various forms of responsibility and other job stresses, may affect various physiological risk factors and cause coronary heart disease. The results that we have presented so far are a long way from adequately testing the model, yet they provide a certain amount of encouragement in leading us to believe we are on the right track. We have found differences among administrators, engineers, and scientists with regard to variables which seem peculiarly associated with heart disease. These differences are in terms of physiology, personality, reported job stress, and smoking. What is lacking are the types of information needed to pin down the causal links between these various panels of variables in the manner suggested in Diagram A.

In some cases, we have found administrators to be relatively high on a particular variable such as a Type A personality variable, yet have found no relationship between that variable and our physiological risk factors. In other cases, we have found some stronger links as is true of the relationship between responsibility for the work of others and cigarette smoking, and between cigarette smoking and blood pressure. What is the explanation for a failure to find relationships between some of the job stress measures which differentiate administrators from engineers and scientists and physiological measures like cholesterol and blood pressure?

For one thing, some of these job stresses and personality variables may relate to physiological risk factors other than the ones being examined in our research. Since there is much literature linking job stress and personality to coronary heart disease, it may be wise to expand our search for related physiological risk factors in coronary heart disease.

Second, some of the relationships between job stresses and physiological risk factors may be masked by personality. As an example, we may find, upon further analysis, that job overload is likely to increase blood pressure if a person is personality Type A,but likely to decrease blood pressure if the person is Type B. Hence the relationship between overload and blood pressure would be cancelled out in a mixed group comprised of both Type A and Type B persons. To give another example, we might find that persons who are high on the need for social approval from others (such as measured by the Crowne-Marlowe) might show increases in cholesterol when they are overloaded with work. Persons who are low on this need for social approval might show no change in cholesterol as their work load changes. Why might this be so? We might assume that for the group of people who value social approval overload can only mean one thing --a potential opportunity to fail at their work and thus lose the social approval of others which they want so much. Thus, overload is stressful and would raise their cholesterol. On the other hand, while overload might cause the persons low on need for social approval to lose such approval, such a threatened loss in social approval would probably not cause their cholesterol to rise because they don't value social approval very highly to begin with. We are already beginning to find relationships of this type which suggest that different personalities take stress in different ways.

Overall, then, we are beginning to pick up relationships between certain types of job stress and risk factors (such as smoking) in heart disease. Furthermore, we are beginning to find differences among the three occupational groups we are studying which appear to be more than coincidentally related to coronary heart disease. An almost mandatory next step following the identification of these relevant variables, is a longitudinal study to begin to carefully tackle the problem of distinguishing between cause and effect in our model.

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