Coronary Heart Disease Deaths Among British and Indian Seafarers

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ABSTRACT

Epidemiological studies on coronary heart disease (CHD) among seafarers have been few, and restricted to developed countries. Some of these studies have demonstrated inconclusive evidence in favour of risk of CHD among seafarers. All these studies being mortality studies it is difficult to predict the true situation as many seafarers may be suffering from CHD though not having succumbed to death. Recent attempts to relate stress at work to coronary heart disease can be extended to the seafaring occupation as seafarers experience stress in an unusual form during their tour of duty. Unusual working hours, monotony of long voyages and watch keeping, being away from home and family, frustration due to lack of leisure facilities and normal sexual activity, smaller working community in modern ships, working with employees from different nationalities, and certain other factors particular to this unusual working and living environment are some of the possible stressors experienced by seafarers.

This study examined the CHD among British and Indian seafarers. As in any other study on seafarer health indices, this study also faced limitations, and thereby the main findings were restricted to proportional mortality rates and crude mortality rates. Being restricted to results on mortality it is difficult to comment on the true occupational risk of CHD posed to seafarers. Further research using complete data is necessary to come to reliable conclusions, a very difficult task to accomplish.

INTRODUCTION

Coronary heart disease (CHD) is one of the most common fatal diseases in the industrialised countries (Cheltin et al. 1990). The situation in developing countries is somewhat different to that of the developed world, possibly as a result of the different life style, especially the eating habits, the different nature of stress experienced and the means of coping them, and the varying genetic predispositions. However, with rapid economic changes that are taking place in the developing world it is not certain as to whether we could continue to believe that there is a significant difference between the CHD epidemiology on either side of the economic demarcation.

Other than genetic, life style and stress related links, CHD has also been linked to occupations. Research during the last 40 years has established that a limited number of chemical exposures directly cause or substantially contribute to coronary artery disease (Fine and Rosenstock 1994). In the last decade, there has been increased interest in the possibility that other aspects of work, such as shift work or work with high demands but in which the worker has little control or influence over how the work is performed, may be additional causal or contributing factors for CHD. Particularly for the postulated non-chemical factors, such as shift work or high demand low control jobs, the increase in the relative risk for CHD is modest. A few occupational exposures have been definitely linked to a wide range of cardiovascular conditions, including CHD, sudden death, myocardial infarction, dysrhythmias, hypertension, and more rarely cardiomyopathy. Several agents are definite cardiac toxins at high levels of exposure, such as carbon monoxide or fluorocarbons, but their effects at more typical levels of exposure are less clear. The three most common suspected factors in a Danish study (Olsen and Kristensen 1991) were monotonous high-paced work, shift work, and passive smoking.

Some of the recent studies on seafarer health have indicated a risk of CHD to a some groups of seafarers. In some other reports, the high proportion of heart disease among seafarers has caused concern. Most of these deaths, especially on board, are however, due to sudden cardiac arrest with no previous indication of heart disease. There is, thus,

no possibility of blaming the quality of pre-recruitment or periodic medical screening for the incidences of these sudden cardiac deaths on board. The increase in a proportion of the cause of death due to one disease could be, purely, due to a decrease in the proportions of death due to other causes. In many work settings, those suffering with chronic illness and disability opt out leaving a healthy group behind. Therefore, in most settings a "healthy worker effect" is created among those remaining healthy employees. The situation is likely to be same among seafarers. Therefore, whether the high proportions of CHD deaths among seafarers, during their tour of duty, is of concern could only be established with more research work in the area. Further, such uncertainty should not preclude showing concerns on seafarers possibly suffering with, at least, "sudden cardiac death syndrome" (SCDS), a phenomenon to which a growing concern has been shown in recent times.

In the light of this situation, a study was designed to examine and evaluate whether there is an occupational risk to seafarers from CHD, selecting British and Indian seafarers as the study samples. The two samples were expected to demonstrate any ethnic differences in the epidemiology of CHD deaths among seafarers.

LITERATURE REVIEW

Coronary heart disease (CHD) is the commonest form of heart disease and the single most important cause of premature death in the developed world (Edwards et al. 1995). Of the 11 million deaths reported in the developed countries each year, roughly 5.5 million or almost exactly 50% are attributable to cardiovascular disease. Of these, 2.4 million (21.8%) are coded to ischaemic (coronary heart disease) (Lopez 1990). In the United Kingdom, it was the main cause of death in all ages in 1993 (Department of Health 1994). In the 55 - 74 year age group, 33% of deaths were due to CHD. One in three men and one in four women die from this disease; an estimated 330,000 people have a myocardial infarct each year and approximately 1.9 million people have angina. The death rates from CHD in the UK are among the highest in the world (nearly 170,000 people died from CHD in the UK in 1992), but are falling slowly. In the United States, CHD accounts for about 45% of all deaths (Fine and Rosenstock 1994). It is now conclusively proved that the occurrence of those diseases in the industrialised countries is related to diet (World Health Report 1996). Epidemiologically, it has also been demonstrated that Caucasians are more prone to CHD, than others. MONICA project reported that there are major differences between populations in non fatal as well as fatal coronary event rates (Tunstall-pedoe et al. 1994). The situation regarding non communicable diseases in developing countries is similar to that in the industrialised world 30 years ago. Coronary heart disease is not the major cause of morbidity or mortality in these countries. In a study in rural India, ischaemic heart disease accounted for only 8.07% morbidity while infectious diseases accounted for 53.2% of all patients (Gupta and Gupta 1993). Of the non-infective diseases 22.5% were due to cardiac diseases. Therefore, at present, there is a noticeable difference between the rates of CHD in developed and developing countries.

Coronary artery disease - causation

Disease of the coronary arteries is almost always due to atheroma (i.e. formation of lipid plaques in arteries) and its complications, particularly thrombosis (formation of clots and blocking of arteries by them). However, occasionally the coronary arteries are

involved in other disorders such as congenital anomalies, aortitis (inflammatory disease of aorta), polyarteritis nodosa and other connective tissue disorders. Atheroma or atherosclerosis is a patchy focal disease of arterial intima (i.e. the inner lining of arteries). Some arteries such as the radial artery and the internal mammary artery are largely spared, while others, notably coronary arteries, are at high risk. Coronary artery, cerebral and peripheral vascular disease often coexist but seldom develop at the same rate. In western countries atheromatous plaques begin to appear in the second and third decades of life. The nature and composition of these plaques change as they evolve. As the lesion grows it encroaches into the lumen of the vessels and erodes the media. The number and the state of evolution of plaques both increase with age, but the rate of progression of individual plaques, even in the same patient is very variable.

Risk factors

The cause of coronary artery disease can be studied either in animal models or by looking for associations between clinical coronary disease and variables such as smoking and plasma cholesterol (Edwards et al. 1995). Animal models do not accurately reproduce human pathology, and epidemiological studies are often unable to distinguish between risk factors, which bear a causative relation to the disease, and risk markers, where the variable measured is not itself the cause, but is linked to something which is. Identification and modification of cardiovascular risk factors have been areas of intense investigation and effort. However, the contribution of known major risk factors (advanced age, male gender, hypertension, elevated cholesterol level, smoking, physical inactivity, and type II diabetes mellitus) do not explain a significant fraction of cases of coronary artery disease (Olsen and Kristensen 1991). Some of the identified risk factors are listed below:

Fixed	Modifiable
• Age	• Smoking
• Male sex	• Hypertension
• Family history	• Lipid disorders
	• Diabetes Mellitus
	• Haemostatic variables
	• Sedentary lifestyles
	• Obesity
	• Polyunsaturated fatty acids deficiencies

The excess risk multiplies when there is more than one risk factor; people with a combination of risk factors therefore have the greatest risk of developing CHD. It is estimated that about 40% of the risk of developing ischaemic heart disease is controlled by genetic factors, and 60% by environmental factors. Hyperlipidaemia, hyperfibrinogenaemia and abnormalities of other coagulation factors are often genetically determined. Patients with familial hyperlipidaemia have a high incidence of premature CHD and many epidemiological studies have demonstrated a positive correlation between mean population plasma cholesterol concentration and morbidity and death from CHD. Tobacco smoking is probably the most important avoidable cause of coronary heart disease. The incidence of CHD also increases with increases of both systolic and diastolic blood pressure. Obesity is probably an independent risk factor although it is often associated with other adverse factors such as hypertension, diabetes and physical inactivity. There is very little evidence to support the popular view that stress causes CHD; however, there is no doubt that stress can aggravate the symptoms of established CHD (Edwards et al. 1995).

Research during the last 40 years has established that a limited number of chemical exposures directly cause or substantially contribute to coronary artery disease (Olsen and Kristensen 1991).[3] In the last decade, there has been an increased interest in the possibility that other aspects of work, such as shift work or work with high demands but in which the worker has little control or influence over how the work is performed, may be additional causal or contributing factors for CHD (Olsen and Kristensen 1991). Some of the non chemical factors, such as shift work or high demand low control jobs, have shown increased risk for CHD.

Some of the risk factors experienced by seafarers can be postulated. Seafarers are exposed to some hazards rarely encountered in other occupations, including unstable platforms, extremes of weather, as well as more widespread hazards such as mobile mechanical equipment and toxic gases. Further, where CHD is concerned, forms of occupational stresses not experienced in any other industry may be playing a major role in causing CHD among seafarers. Unusual working hours, monotony of long

voyages and watch keeping, being away from home and family, frustration due to lack of leisure facilities and normal sexual activity, smaller working community in modern ships, working with employees from different nationalities, and certain other factors particular to this unusual working and living environment are some of the possible stressors experienced by seafarers. Also, at sea there is no direct access to qualified medical assistance to handle accidents or serious illness.

Seafarers and coronary heart disease

Much concern has been shown on the incidence of coronary heart disease among seafarers from developed countries. These concerns have been shown as some of the studies by Rafnsson and Gunnardottir (1994), Zorn et al. (1977), Harrington (1972), Brandt et al. (1994), Levy (1972) conducted in these countries demonstrated a risk of CHD to seafarers. In some instances, the higher proportions of deaths due to CHD have been used as the statistic to make conclusions. A Danish study (1986 - 93) showed that more than 50% (29/53) of natural deaths occurring on board Danish merchant ships were due to CHD; this was a study demonstrating the higher proportion and not a proportional mortality ratio. Hansen, from this study, has identified maritime work place as a high risk work place (Hansen, 1996). Similarly, Urner (1975 - 89) observed that a high proportion of all deaths, 56/102 (54.9%) among seafarers signed on ships of an American shipping company, was due to myocardial infarction. The statistics available from Japan (from ship-owners accident and disease reports, 1987 - 1992) showed that heart disease was one of the three common causes of death among seamen. In the UK, 42% of natural deaths on board in 1994 was due to CHD (British Chamber of Shipping 1994). CHD was also the commonest reason for refusal at seafarer medical examinations (24% compared to 18% in 1993). The fatalities among group of Swedish seafarers (1984 - 1988) were also attributed principally to cardio vascular disease (Larsson and Lindquist, 1992). However, the influence of a "healthy worker effect" on generating high proportions in these studies is reiterated here.

There are other studies that have made use of other parameters, like age, job category, race etc., to make conclusions. A study in South Africa found a higher incidence of

CHD deaths among officers. Researchers in that study considered that it may have been due to their average age being higher and by their greater responsibilities, but more likely due to a racial difference as officers were of European extraction and the ratings from the Cape coloured population. A Swedish study (1992) observed that the risk of death due to myocardial infarction for deck officers was higher than that for other occupational groups ashore (age adjusted relative risk of 1.9, CI - 1.0 - 3.4). Contrary to above mentioned studies, Brandt et., al. 1994 observed that CHD was more prevalent among the engineering crew.

Some studies have examined, both exogenous and endogenous, cardiovascular risk factors. Kelman & Kavler (1985) reported a high percentage of hypertension (30.9%), previous heart conditions (7.5%) and rheumatism (20.9%) among seafarers. Kliz et al. in Gydnia found positive electrocardiographic indicators for ischemic heart disease in 42% of seafarers when tested by a sub-maximal exercise test. Offer & Ohlsen (1981) observed that out of 2,646 seamen 8% suffered from cardio-vascular disease and they had previous experience of pre-cordial pain, suffered from hypertension and gave a history of previous myocardial infarction. Overweight among seafarers has also been identified as a cause of CHD. In an oil tanker, Arabia Maru, in the Peruvian Gulf, seamen showed an average overweight and excess subcutaneous fat as well as lack of exercise (Nakamura, 1993). Pedometer measures also showed that the number of steps taken by seamen per day was 1,020 (Engine room personnel) and 7,940 (in stewards from catering departments) which were far below that of an average Japanese man (10,000 to 12,000 steps per day). In another study among the merchant mariners the ECG was found to be abnormal in 8.3% who also happened to be overweight and obese (Waskiewicz, 1991).

Some work has also been carried out to examine the cardiac function parameters. Early Japanese studies showed increased heart rate up to 140 beats per minute in captains while maneuvering ships near ports in heavy traffic (Ohashi & Sugihara, 1967; Ohashi & Hirota, 1969). Cardio vascular stress was observed in Swedish coastal pilots too, when confronting on-coming traffic (Kilbom, 1969) which was also confirmed at the Institute of Work Physiology in Oslo (Rodahl, 1989). They found increased heart rate

up to 150 bpm and significant rise in systolic and diastolic blood pressure and also excretion of catecholamine (stress related hormone) in urine. An elevation of BP has been found in other stressful occupations like tax occupations and shift workers, telephone switch board operators and air traffic controllers (Steward, 1990). These heightened reactions occur with minimal physical effort indicating the physiological changes experienced by ships' captains, very likely due to psychological stress at these times of high mental demand. The highest heart rate (130 to 170 bpm) was observed in engine room crew when climbing up and down stairs and in deckhands when they were handling anchors, ropes, buoys and cargo. This level of cardio vascular strain was observed during moderate to intense exercise. Heart rate was generally higher (180 to 170 bpm) when performing duties in rough seas and high winds in small boats rather than in larger ships (Yokoyama, et., al. 1994).

Study of abnormal ECG tracing was observed in 10.9% of Chinese seafarers and 40% showed hyperlipidemia (Jinzhong, 1991). In Poland, myocardial (heart) ischaemia was diagnosed in 2.27% of 3,000 seafarers in 1971-74 and 3.0% of 3,300 seafarers in 1983-85. The development of this ischaemia was considered to be the result of working environment, alienation, habits and lack of motion (Filikowski, 1989). In a 1992 phonocardiographical study of 763 randomly selected seafarers, systolic zone clicks and aortic sounds were evident in this population and not in the control group of people (Waskiewicz, 1992).

Age also has been considered as a predisposing factor as some risk factors increase their influence with age. Both systolic and diastolic pressure was found to be increased with age, specially with engine room personnel showing higher blood pressure than others; 49% of those who died were between 35 to 54 years, the chief cause of death being coronary thrombosis. Majority of these seafarers were over 35 years of age and showed a deteriorated quality of life (Dyer-Smith & Stein, 1993; Ejmont, 1961). In another study, ischemic heart disease showed an increase with age over 40 years and with length of seafaring careers (Kliz, et., al. 1990). An increase in total cholesterol level with age also suggests a probable dietary and life style pattern of seafarers (Brown, 1990; Berger, 1983).

Much importance has been paid to the relationship between occupational stress and heart disease in the recent past. Effects of stress on health are not restricted to any particular occupation. Studies have been conducted on psychological factors in relation to seafarers and their health. Hellesoy thought that isolation from family and friends (Hellesoy, 1985) experienced by seafarers, along with fatigue and poor sleep due to disruption of circadian rhythm, created a perceived risk and anxiety. Further, multicultural environment, reduced manning, boredom and rejection, interaction mostly with monitoring equipment reduce their social contact and increase the risk of IHD (Johnson, et., al. 1994; Jepsen, 1991; Dyersmith & Stein, 1993). Irregular working hours, changing and variable climatic conditions, which can cause a major disturbance in body's biological rhythms with resultant physiological strains, which in turn affecting the cardiovasular function, add to the long list of stressors. Nakamura (1973) also has attributed the technological development and size of the ship, i.e., larger ships with less manning, to increase stress and anxiety resulting in diseases of the circulatory system. In a longitudinal study (Filikowski, 1989) carried out from 1970s-1980, on 15.5% of seafarers with neurotic symptoms, there were about 55% of them suffering from arterial tension, gastric and duodenal ulcers, urolithiases and coronary ischemia. In another study among Polish seafarers, it was observed that the majority of repatriated seafarers suffered from mental disorder and disturbance of nervous symptoms as well as circulatory symptoms (Tomazunas & Mrozi Ski, 1990).

Apart from having effects on CHD, stress directs seafarers to find refuge in cigarette smoking and alcohol consumption, especially the former having a well demonstrated contributory effect on CHD. Smoking and high serum cholesterol was evident in 350 seafarers in Poland (Thomaszewski et., al. 1990). In this study, 10 out of 11 sea captains were heavy smokers (>= 20 cigarettes in a day) with higher body weight and lower physical performance. All the sea captains showed pathological exercise. This demonstrated coronary artery disease in apparently asymptomatic, healthy middle aged seamen.

Drinking too has its fair contribution towards seafarers' health. A study on 194 seafarers revealed problems in relation to work and home to be a strong predictor of both job dissatisfaction and mental ill-health (Cooper & Sutherland, 1987). The sea captains and the chief engineers had a higher level of serum cholesterol, uric acid, haemoglobin level and leucocyte count which were associated with smoking, alcohol and lack of leisure time physical activity than shore working men (Carel, 1990). Daily consumption of alcohol can result in number of physical effects on a seafarer's health. A primary effect was seen by elevation of blood pressure (Berger, 1983).

The effect of temperature and noise, on CHD or related factors, has also been studied. The high temperature in the holds of ship's engine rooms has shown to manifest diseases of the circulatory system which has significantly increased diastolic pressure. Even the noise and vibration has shown an increase in blood glucose and serum beta lipo-protein concentrations (Rumyantsev & Mekell'son, 1971). Noise exposure in engine room is a probable cause of greater arterial hypertension than persons not exposed to such noise levels. It has also been suggested that the degree of perceptual hearing loss is a good indicator of the relationship between noise exposure and blood pressure (Vukeli et., al. 1989).

Life expectancy of seafarers also has been queried. One Danish shipping company reported (Seafarers International Research Centre 1996) that none of its masters lived to reach the retirement age of 65. All the issues related to CHD can be addressed only by properly conducted research studies. This study, not withstanding the major limitations faced, attempted to examine some of the issues.

METHOD

This study examined the incidence of coronary heart disease deaths among British and Indian seafarers. It must be stressed that conducting a global or an international study on coronary heart disease among seafarers is difficult, or somewhat impossible, as the shipping industry in most countries do not record data or maintain statistics on seafarer health indices including those of coronary heart disease. The current study was no exception in being subjected to this major limitation. This study was subdivided into:

A study of CHD among active seafarers
A study of CHD among retired seafarers

To examine the CHD occurrence between two ethnic groups, the above described sub studies were carried out among British and Indian seafarers. The study in the UK was faced with further limitations in that data were available only on CHD deaths on board or within 30 days of signing off.

The Study in the UK

Subject to mentioned limitations, the UK study examined the proportions of death due to CHD, CHD mortality rates, Proportional Mortality Ratios (PMRs) for CHD and the mean age at death due to CHD in both active and retired seafarers.

The records of death certificates and the circumstances that led to a seafarer's death were obtained from the archives of the Registrar General for Shipping and Seamen(RGSS) in Cardiff. The Registrar General for Shipping and Seamen (RGSS) is the official British Authority which registers the deaths of British subjects which occur at sea. The master of a British-registered ship is obliged to notify the RGSS of any deaths arising at sea among the crew who are signed on the vessel's articles. Notification of the death may also come from authorities such as the Department of Transport, Marine Office, a HM Coroner, a Procurator Fiscal or, where deaths arise in

foreign countries or foreign waters, the British Consulate or the Embassy. Moreover, for the purposes of registering seafarers deaths, the RGSS has maintained a policy of following up all official inquiries into deaths involving British seafarers. The individual files at the RGSS contain all compiled documents relating to the death of a seaman. It is assumed, therefore, that these files cover virtually all of the deaths occurring among British seafarers in British registered vessels. Information is often obtained from the flag state administration or from the British sources listed above. It is also expected that the files in the RGSS would cover the large majority of deaths among British seafarers in foreign fleets. All files related to seafarers who died whilst employed in British and foreign merchant vessels between 1st January 1986 and 31st December 1995 were examined. Death files and the data base of the principal official maritime investigative authority, the Maritime Accidents Investigation Branch (MAIB) were also inspected. The annual Lloyds Vessel registers were then consulted to verify whether each of the deaths occurred from a merchant vessel of over 100 gross tonnage which was registered from a British port at the time of death.

A total of one hundred and seventeen deaths satisfying the inclusion criteria were identified. The reports of post mortem examinations and Coroner's inquests were provided by many HM coroners throughout England and Wales, whilst additional information on some deaths was obtained from the Marine Office in Southampton and Health and Safety Executive offices.

To determine the true mortality rates, the numbers of the population at risk are required, for each year of the study period. Such definitive information is not available at the Department of Transport, UK, not to mention the maritime administrations of many Flags of Convenience (FOC) and foreign fleets. The 'estimates' of these numbers (i.e. the denominator data for computation) were obtained from other reliable sources (British Chamber of Shipping). These were used only for computing crude analyses, as they were not exact numbers, but estimates. British Chamber of Shipping, through their annual Fleet Manpower Inquiries provide estimates of the numbers of seafarers manning UK and foreign-registered ships which are owned by their affiliated (British) companies. These estimates, however, exclude foreign companies employing British

seafarers, and British companies, employing British seafarers, which are not affiliated to the chamber.

Inclusion criteria (UK study)

Included in this study were all CHD deaths occurring among British seafarers employed in privately-owned British, or foreign-flagged, merchant vessels of 100 gross tons or more. Excluded are crew serving on board non-merchant vessels such as fishing trawlers, government-owned vessels, naval ships and pleasure craft, as well as those working on board small merchant ships (less than 100 grt). Also included are seafarers who died after being landed ashore as a result of an acute illness due to suspected coronary heart disease, provided that death occurred within 30 days of being landed ashore and signed off the vessel's article of agreement. Non-crew members who died aboard the merchant vessels but not signed-on articles of agreement are excluded e.g. passengers, stowaways, pilots, roughnecks, dock workers, commercial divers, cargo inspectors, oil rig workers, etc. Seafarers who died within hours of joining a merchant vessel but had not gone through the formalities of signing-on were included.

In retired seafarers, the data (1986 - 1996) to compute the mean age at death were obtained from the Merchant Navy Officers and Ratings provident Funds (MNO/RPF).

The study in India

The study in India evaluated the crude mortality rates (as age profiles were not available), and compared them with the rates of a shore based occupation. The mean age at death due to CHD over a period of 10 years i.e. 1st January 1985 to 31st December 1994, was also computed. The analyses were restricted to computing of these statistics as the data were incomplete.

The letters, to obtain permission to examine the records of CHD deaths, were sent to shipping authorities, shipping companies, offices of the Seafarers' Welfare Fund Society and the Commissioner of Workmen's Compensation, Bombay Port Trust (BPT)

Hospital and the BPT Administrative office in Bombay. The shipping companies contacted provided records only for a period of 2 - 4 years, the Shipping Corporation of India (SCI) providing records of four years. Data for the rest of the study period were obtained from the Seamen's Employment Office in Bombay as the offices of other authorities contacted could not provide any data. As the data obtained from these sources were incomplete, the study was extended to obtain more data to complete the records by carrying out a questionnaire survey among the families of the deceased, having obtained their names from the Seamen's Employment office. An information seeking questionnaire was sent to the immediate families of all deceased seamen, along with a self-addressed stamped envelope to reply. A response rate of 65% was achieved in the survey. In situations where the necessary information was not obtained, letters were sent again to the families to come for an interview with the research team. Personal interviews were conducted with the family members if they were close to Bombay or Goa. The research team availed the facilities at the National Union of Seafarers of India (NUSI) in Bombay and Goa to interview the family members of the deceased sailors. It was a difficult task to obtain data as the families of the seafarers were spread throughout India.

The Bombay Port Trust (BPT) was selected as the comparison group (on-shore occupation) for the study. Data were obtained from the BPT Hospital and BPT Administration Office. In cases where records were not complete, a similar procedure, as for seafarers, was followed to obtain information.

In both groups, seafarers and BPT employees, some families of the deceased were not traceable as they did not live at the available address any longer. Poor literacy rate among the family members and the lack of interest to provide information were the other major limitation in collecting data. The denominator data, in the case of active seafarers in India was easier to obtain as the companies contacted had such records. The numbers of persons employed at the BPT was available for the years 1994 and 1995. However, it was difficult to obtain complete denominator data and data on CHD deaths of retired seafarers.

Statistical Analyses and computation

In the British study the data were entered, edited and analysed, at the Seafarers International Research Centre using the SPSS software package. In India, the data were analysed at the Women's University of Bombay.

Due to lack of denominator data Proportional Mortality Ratios (PMRs) are widely used in national statistics presentations on occupational mortality indices. To calculate a PMR, the proportion of deaths in the general population from a particular cause of death is needed. This proportion is then applied to the number of deaths in the occupation group being considered to produce an expected number of deaths from the particular cause. The ratio of the actual number of deaths to the expected number of deaths is multiplied by 100 to give the PMR. If the observed number is greater, or less, than expected, the PMR will be greater, or less, than 100. PMRs, for the diseases suffered by seafarers are available in the UK, and such statistics have been made use of, in this study.

RESULTS

The results of the two sub studies are presented separately.

British study

Active seafarers

Frequency and proportions of deaths

Table 1 shows the frequency and the proportion (percentage) of deaths due to natural deaths during the study period. In both British and non-British vessels, the proportions of deaths on board due to CHD were in excess of 85%, while the proportion in both types of vessels (i.e. together) was over 90%.

Table 1. Causes of Natural Death among British Seafarers serving British and Non-British Merchant Vessels (1986 - 1995)

Cause of Death	Frequency (on Board British Ships)	Frequency (on Board Foreign Ships)
Coronary Heart disease	67 (89.3%)	38 (90.5%)
Gastro-Intestinal disease	4 (5.3%)	1 (2.4%)
Cerebro-vascular disease	2 (2.6%)	3 (7.1%)
Infectious diseases	0	0
Respiratory diseases	2 (2.6%)	0
Other disease	0	1 (2.4%)
Total	75 (100%)	42 (100%)

Note: Total CHD deaths = 91.3%

Occupational Proportional Mortality Ratios in the UK

Table 2 shows the seven highest PMRs (for CHD deaths) for men (occupational groups) in the UK for the years 1979-80 and 1982 -90 in the age group 20-74, including those for seafarers (Coggon et al. 1995). The highest PMR recorded for men was 120 (in clergy). The ranking of PMRs did not point to any obvious occupational hazards and the jobs at the top of ranking were not those that would be considered unusually stressful. Nor were they all sedentary occupations. In seafarers, the PMR was less than 100, both when age groups 20-64 and 20-74 was considered.

Table 2. Proportional Mortality Rates of Men aged 20 - 64 for Coronary Heart Disease (ICD 410-414) and Job Group, England and Wales, 1979-80, 1982-90

Job Group	No. of Deaths	PMR	95% CI
014 Clergy	1696	120	114-126
107 Pattern makers	516	119	109-130
181 Road transport inspectors	1121	115	109-122
094 Compositors	817	113	106-121
031 Draughtspersons	2502	113	108-117
040 Managers in transport utility and mining	6853	113	110-115
023 Driving instructors	787	112	104-120
036 Seafarers[a]	2609	81	78-84
	1700[b]	84[b]	

NOTE: a - includes all types of seafarers and all CHD deaths in the age group 20-74; b - age group 20-64

Table 3 shows the PMRs (adjusted for age and social class), with a significant difference from 100, for diseases including ischaemic (coronary) heart disease in seafarers for the years 1979-80 and 1982-90 in England and Wales (Coggon et al. 1995). The PMR for CHD (Ischaemic Heart Disease) was significantly less than 100, confidence interval being 78 - 84.

Table 3. The Numbers of Death and PMRs in Male Seafarers Aged 20-74 during 1979-80 and 1982-90 in England and Wales

Cause of Death (ICD)	The Number of Deaths	PMR	95% CI
Tuberculosis (010-018, 137)	32	185	126-261
Cancer of the oral cavity (141,143,144,145)	56	273	207-355
Cancer of pharynx (146-148)	45	290	212-388
Cancer of liver (155)	46	154	113-206
Cancer of larynx (161)	67	242	188-307
Cancer of trachea, bronchus and lung (162)	1143	110	104-117
Urolithial cancer (188,189.1-189.8)	78	78	62-97
Cancer of the brain (191)	47	62	46-82
Non-Hodgkin's lymphoma (200,202)	48	72	53-96
Other alcohol related diseases (303,305.0,425.5,535.3,571.0-571.3,E860.0,E860.1)	154	309	262-362
*Ischaemic heart disease (410-414) **	*2609*	*81*	*78-84*

Table 3. (Contd.)

Cause of Death (ICD)	The Number of Deaths	PMR	95% CI
Cirrhosis of the liver (571.5)	81	256	204-319
Pancreatitis (577.0,577.1)	27	170	112-248
Osteoporosis (733)	5	355	115-828
Motor vehicle traffic accidents (E810-E819)	107	81	66-97
Water transport accidents (E830-E838)	104	2088	1706-2531
Cold injury (E901)	8	321	139-633
Suicide (E950-E959)	126	83	69-98
Injury undetermined whether accidentally or purposely inflicted (E980-E989)	93	184	149-226
Unspecified pneumonia (486)	22	175	110-265
Chronic bronchitis and emphysema (491,492,496)	525	114	104-124
coal workers' pneumoconiosis (500)	0	0	0-34
Gastric ulcer (531)	37	184	129-253
Bronchopneumonia (485)	222	144	126-165
Other cerebrovascular diseases (431-438)	659	110	102-119
Pneumococcal and unspecified lobar pneumonia (481)	46	150	110-200

NOTE - * PMR for CHD for Male nurses 99 (CI - 83-117); Stevedores, dockers 103 (87-121)

Mortality Rates

It was difficult to compute the mortality rates due to CHD as the exact numbers of seafarers serving the British and Foreign registered vessels were not known for each year, and thus for the whole study period. A previous rate (Roberts 1997) for death on board (computed using estimates of seafarers numbers), among British seafarers employed on board British merchant vessels (Table 4), was 2.4 deaths per 10,000 person (seafaring) years. This was very much less than the mortality rates (Tunstall et al. 1994) due to CHD among males and females in Glasgow (30.82 / 10,000 person years) and Belfast (20.70 / 10,000 person years) in the 35-64 year age group. However, this study and other previous studies could collect only the data pertaining to deaths on board or 30 days after leaving the ship, thus missing some numbers, in the age group 20-64, of CHD deaths among seafarers which occurred during long leave periods or "off article" periods.

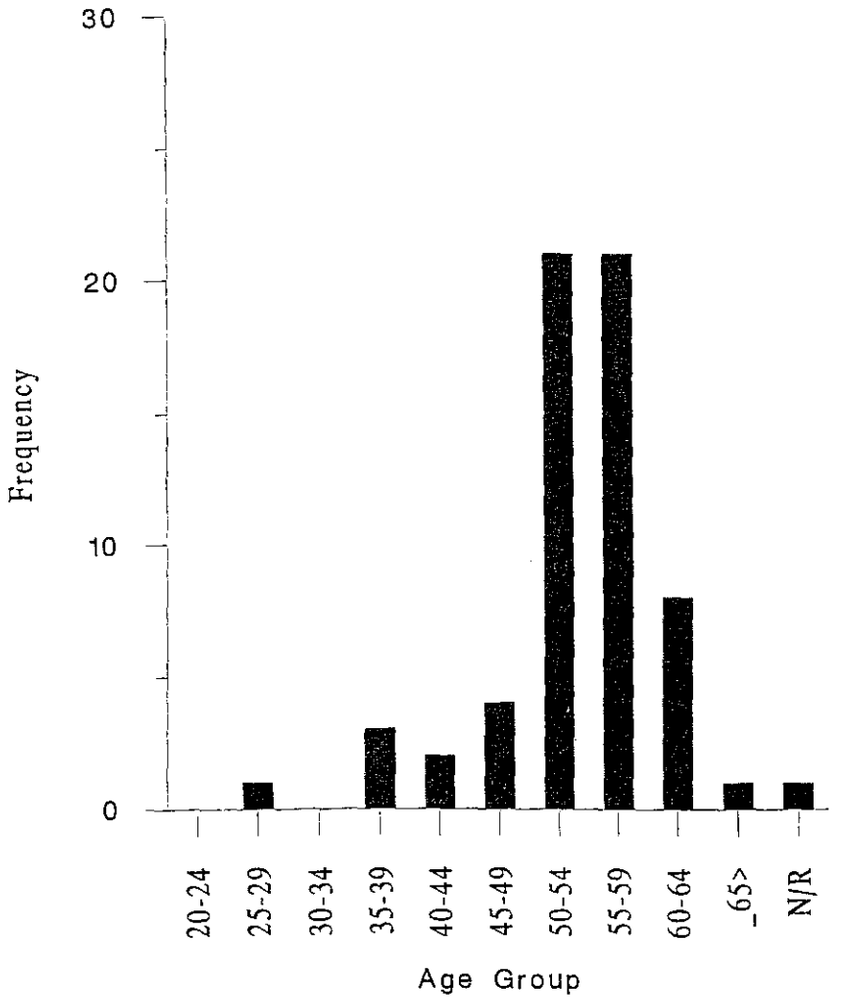
Table 4. Cause specific Mortality Rates among British Seafarers employed on board British Merchant Vessels (1986 - `1995)

Cause	Frequency	Mortality Rates[a]
All non-natural deaths	91	3.6
Maritime disasters	46	1.8
Occupational accidents	15	0.6
Other accidents	10	0.4
All natural deaths	68	2.7
Coronary heart disease	62	2.4
All unknown causes	22	0.9
All fatalities	182	7.2

NOTE: a - per 10,000 seafaring (person) years

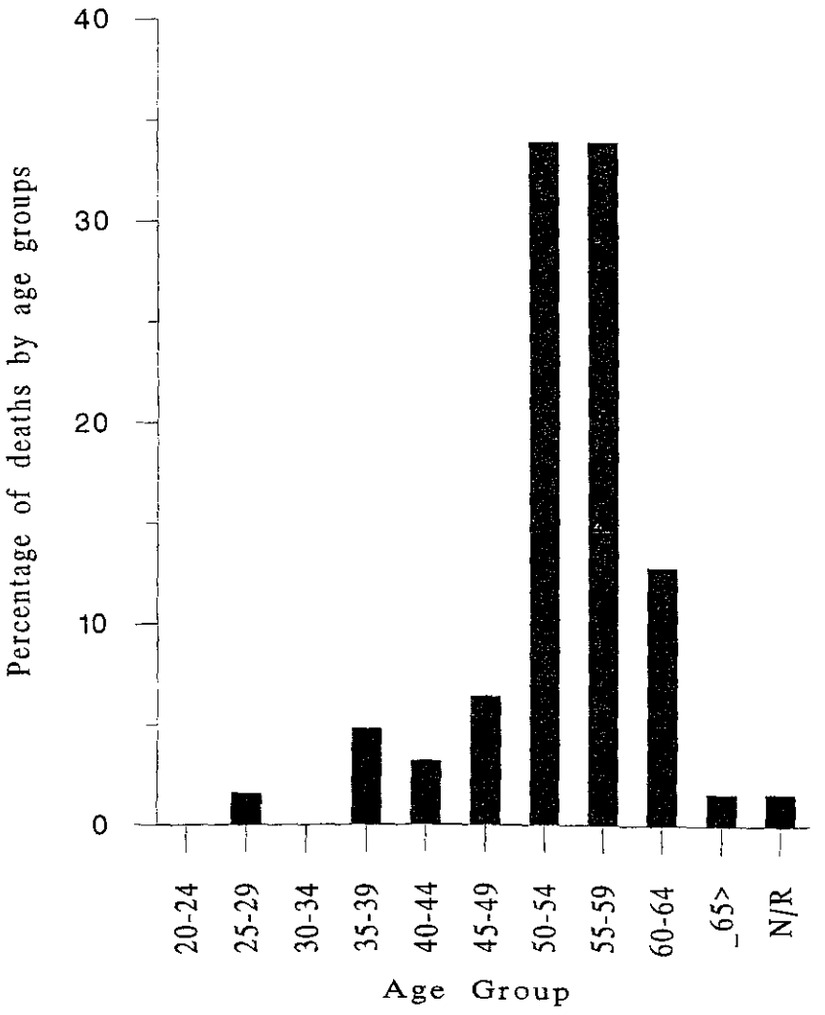
The age at death

Figures 1 and 2 show the frequency and the proportions of deaths by age groups respectively. The highest numbers and percentages were observed in the age groups 50-54 and 55-59.



Note: N/R - Not Recorded

Figure 1. The frequency of CHD deaths among British seafarers, stratified by age groups



Note: N/R - Not Recorded

Figure 2. The percentage of CHD deaths among British seafarers, stratified by age groups

Mean age

The mean age at death due to CHD, of active seafarers, was 53.3 (Roberts 1997). This age was noticeably higher than the mean ages of those who died from all other categories of natural deaths (45 years), occupational accidents (43 years) and other, off duty accidents (42 years).

Retired seafarers

Coronary heart disease as the cause of death

Table 5 shows the numbers and the causes of death among retired British seafarers. While 959 (21.8%) seafarers had diagnoses related to coronary heart disease (in italics) as the primary cause of death, 1258 (28.6%) succumbed to death due to a myocardial infarction, given as the secondary cause of death in their death certificates.

Table 5. The Frequency of Deaths due to Different Causes among Retired British Seafarers (1986 - 1996)

Primary Cause of Death	Frequency	Percentage
Malignant disease	1213	27.6
Cirrhosis of the liver	90	2.0
Bronchoneumonia	170	3.9
Diabetes Mellitus	86	2.0
Hypertension	129	2.9
Atherosclerosis	*134*	*3.0*
Blood disorders	3	0.1
Renal failure	84	1.9
Nephrotic syndrome	4	0.1
Polycystic disease of the kidney	2	0.0
Poisoning	11	0.3
Emphysema	50	1.1
Thrombosis / Embolism	*142*	*3.2*
Heart disease	*522*	*11.9*
Atheroma	*161*	*3.7*
Peritonitis	27	0.6
Chronic obstructive airways disease	176	4.0
Infectious diseases	40	0.9
Other illness	240	5.5
No cause given / old age	1114	25.3
Total	4398	100.0

The age at death

Table 6 shows the mean age, median age at death due to CHD and the percentiles of seafarers living at ages of 65 years and 75 years together with similar available statistics among the British population. The mean and the median ages of death, in retired seafarers, due to myocardial infarction was 70.3 years (SD ±9.47) and 69.7 years respectively. Percentiles demonstrate that 25.8% of retired seafarers die at or before 65 years of age due to CHD while 71.5% died at 75 years of age, demonstrating a higher incidence of death in the 10 year age period between 65 and 75 years. Percentage of retired seafarers dead at 75 years was 71.5%. However, this was less than the percentage of British population (including women) dead at the same age (i.e. 93%).

Table 6. The Ages at Death of Retired British Seafarers compared to the British Population

Population Group	Mean (±SD) Age	Median Age at death	Percentile Living at 65	Percentile Living at 75
Retired Seafarers due to CHD	70.3 (±9.47)	69.7	74.2%	28.5%
Retired Seafarers due to all causes	69.96 (±10.4)	69.8	72.7%	23.7%
British population[b]			15.7%[a]	7%[a]

NOTE: a - 1990 estimates; b- Donaldson and Donaldson 1993.

Indian Study

Mortality Rates

Table 7 shows the annual crude mortality rates (i.e. not age adjusted) among all active Indian seafarers. There is an increasing trend shown in the rates (Figure 3) over the years.

Table 7. Crude CHD Mortality Rates of Indian Seafarers and BPT Employees (1985 - 1995)

Year	Number of Active Seafarers	Number of Deaths	Crude Mortality Rates[a] (per 10^4)	Crude Mortality Rates[a] among BPT Employees
1985	25416	13	5.1	--
1986	25416	17	6.7	--
1987	25145	25	9.9	--
1988	21769	14	6.4	--
1989	18766	23	12.2	--
1990	18372	40	21.8	--
1991	16294	52	31.3	--
1992	16340	59	31.8	--
1993	16230	72	43.1	--
1994	16173	99	57.5	10.4[b c]
Total	199921	414	20.7	

NOTE: a - of active seafarers; b - denominator data available only for 1994; c - rate in 1995 = 26.1 (seafarers - 38.8)

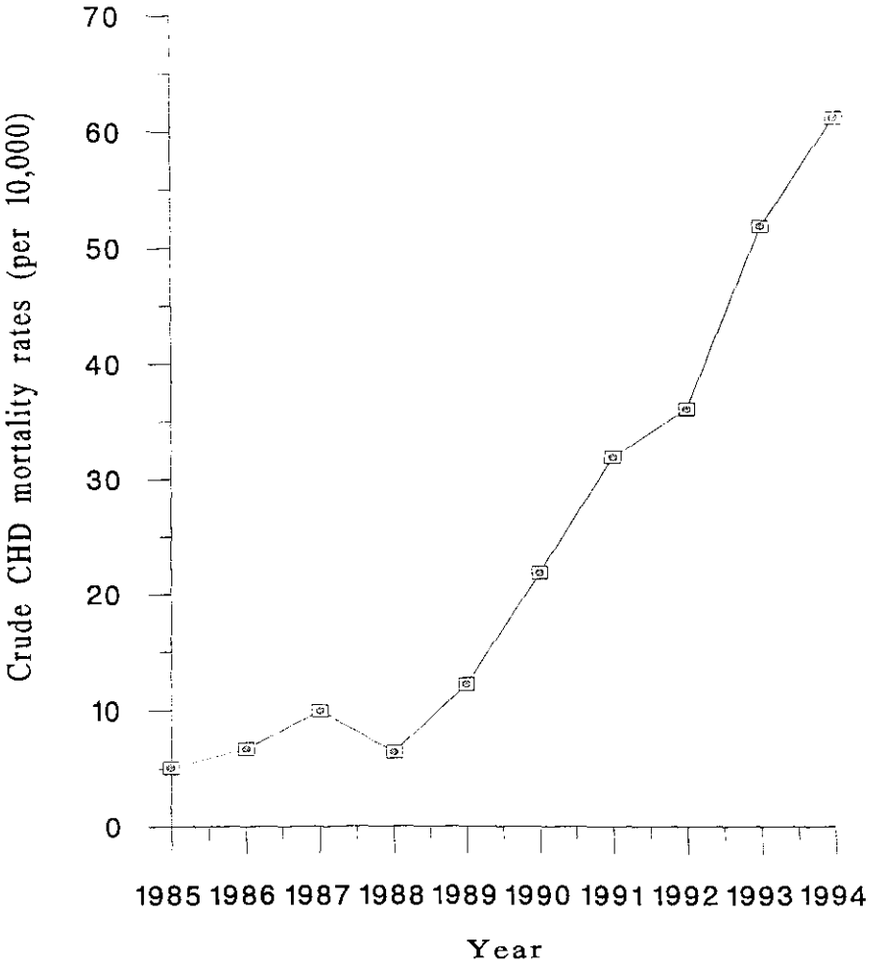


Figure 3. Variation of crude CHD mortality rates over the study period

Table 8 (Appendix I) shows the annual crude CHD mortality rates (i.e. not adjusted for age) among different job categories of all seafarers during the study period. It was observed that the ratings demonstrated higher rates than officers.

Age at Death

Table 9 shows the age at death due to CHD. The mean value of age at death ranged from 44.41 to 51.72.

Table 9. Mean Age (±SD) of Death among Active Seafarers (1985 - 1994)

Year	Number of deaths	Mean (± SD)
1985	13	49.38 (6.66)
1986	16	44.41 (3.46)
1987	26	49.85 (5.09)
1988	14	51.21 (3.32)
1989	23	49.26 (4.80)
1990	39	51.54 (6.24)
1991	51	51.00 (7.14)
1992	52	49.72 (7.23)
1993	70	51.72 (8.36)
1994	93	49.55 (9.21)

Table 10 shows the differences between the mean ages of death due to CHD among active seafarers and active BPT workers during the study period. It was observed that BPT employees died of CHD at a younger age than the seafarers, the difference in one study period being statistically significant.

Table 10 Comparison of Age at Death due to CHD between Active Seafarers and BPT Employees

Years	Mean (±SD) age (active seafarers)	Mean age (active BPT workers)	t value and significance
1985 - 1989	48.8 (6.4)	48.7 (7.41)	0.25
n = 132			
1990 - 1996	51.01 (8.01)	47.32 (8.40)	4.55
n = 479			($p < 0.01$)
1985 - 1996	48.99 (7.90)	47.63 (8.45)	1.68

Age at death of retired seafarers

The mean age at death, due to CHD, among retired seafarers (1990 - 1996) was computed only from 45 cases (available data). The mean value was 61.62 (±SD) years.

Comparison of mortality patterns between British and Indian seafarers

The only comparison that could be made was between the proportions of death due to CHD on board among the two groups. British seafarers demonstrated a significantly higher proportion of deaths due to CHD during the period 1986 - 1995 (Table 11).

Table 11. Comparison of Proportions of Death due to CHD among British and Indian Seafarers

Seafarer Group	Deaths due to CHD	Deaths due to other illness
British	105	13
Indian	208	56

Note: Chi square = 5.37 ($p < 0.05$)

DISCUSSION AND CONCLUSIONS

The main objective of this study was to re-examine the current thinking with regards to the risk of coronary heart disease among seafarers. Some of the earlier studies by Rafnsson and Gunnardottir (1994), Zorn et al. (1977), Harrington (1972), Brandt et al. (1994), Levy (1972) have shown a risk of CHD to active seafarers. These studies demonstrated a CHD risk for some groups of seafarers in Denmark, Sweden, the UK, USA, South Africa and Japan, the only countries where published research studies have been conducted. Further, there was no consistency in the findings in that some groups within the seafaring occupation were shown to be at risk in some studies while such a feature was not demonstrated in others. In some situations, especially the media, the high proportions of death due to CHD has been made use of to cause an alarm. As mentioned earlier, proportions of death or illness should not be used to make conclusions as lessening of deaths or episodes due to other illnesses increase the proportion of death due to CHD, creating a false situation. However, proportional mortality ratios are a better indicator i.e. an age adjusted comparison with the proportions in the general population.

In the British study, it was not possible to obtain exact denominator data to compute a realistic figure for mortality rates for CHD deaths. The mortality rate (2.4/10,000 person years) computed, using estimates of denominator data, was very much less than CHD death rates (per 10,000 person years) of the general population (35-64 year age group) of Glasgow (30.82) and Belfast (20.70) during 1985 - 87 period. However, the latter population statistics also included the deaths among females, and the seafarer statistic did not include deaths that may have occurred during leave and of those "off articles". In most occupational situations where mortality or morbidity rates can not be computed, PMR statistics are used to indicate risk. The PMR value (81[CI[1] 78-84]) for British seafarers (aged 20 - 74) for the years 1979-80 and 1982 - 1990, being less than 100, did not demonstrate any CHD risk.

[1] Confidence Interval

The age at death due to CHD on board has also been of concern. This study demonstrated that the mean age at death due to CHD on board or within 30 days of leaving the ship (53.3), in the UK, was higher than the mean age at death due to other natural deaths on board (45 years). The results generated in India was same; seafarers died of CHD at a higher mean age than the employees of the shore based occupational group (Table 10). The retired seafarers in the UK, contrary to an earlier belief, did not die of CHD at an earlier age than the general population in the year groups over 65. Lesser proportion of retired seafarers died of CHD, than the general male population of England and Wales, in the age groups over 65 years (Table 6). No comments can be made of the retired seafarers in India as the data available on seafarers were incomplete.

In India, crude mortality rates could be compared, with that of the comparison group, only in the year 1994. In this year, the mortality rate among seafarers who were active on board, registered, or "off articles" (57.5/10,000 person years) was higher than that computed for BPT workers (10.4). Conclusions can not be made from comparison of crude rates in one year. Further, the crude mortality rates computed for seafarers ranged from 5.1 in 1985 to 57.5 in 1994. The increasing trends in rates observed (Fig. 1) can be spurious as it was very likely due to the improvements in data recording systems in the latter part of the study period. Further, these rates were crude mortality rates which may demonstrate no increase in risk if age, and smoking status was adjusted. A future study using the same cohort of seafarers, with the availability of smoking status and age profiles could demonstrate a realistic figure of risk.

The findings of this study, again, does not provide an avenue to make firm conclusions regarding a risk to seafarers from CHD. The PMRs provided in the Decennial Supplement demonstrate no risk to British seafarers. The mortality rate ($2.4/10^4$ person years) computed in the UK study, though small, has to be taken with

much caution as some deaths among British seafarers may not have been recorded and more the numbers used for the computation was only the deaths that occurred on board missing a large number of CHD deaths that may occur among "off article" seafarers and those seafarers who were on leave. The magnitude of the difference in numbers, of deaths occurring at these different situations (i.e. on board and ashore), was well demonstrated in the Indian study. In the Indian study (1985 - 94), only 42% of deaths due to CHD among seafarers who were active, "off articles" and "on leave" were recorded as deaths on board while 58% of the CHD deaths occurred outside the confines of the ship. If the same ratio is applied to the British seafarers, with exact numbers of registered, off article and on leave seafarers' death known, the CHD mortality rate may be higher than the rate computed from an estimated denominator figure. However, based on PMR values, it can be predicted that CHD mortality rates may also be less than that of the male population, of the same age group, in the UK. No comments can be made of the risk of CHD to Indian seafarers.

It is also very important to note that all studies related to CHD among seafarers have been mortality studies, and results have been generated without adjusting for smoking status of the deceased. No one can find much fault with the researchers as complete data, if at all, are found on the numbers of deaths only. Further, all of the studies being retrospective studies it would have been almost impossible to obtain data on the smoking status of the selected cases of death. Seafarers being a "floating" population i.e. moving from an active sea-going phase to shore jobs, being on and off articles, such a situation has led to a lack of a proper illness / death recording and registering system in most countries in the world or even in most shipping companies in the world. This situation prevents conducting properly designed morbidity studies. Further, the mortality studies may be providing spurious results and thus wrong conclusions if most of the deaths recorded as CHD deaths are 'sudden cardiac deaths' (SCDs), a completely new clinical entity. Therefore, as long as proper data collection and recording systems are not implemented in the shipping industry, we remain in the darkness, not only in gaining more knowledge on CHD among seafarers, but also on many other illnesses experienced by international seafarers.

This opportunity is therefore made use of to show the importance of a standardised data collection and recording system for seafarer health indices.

Many seafarers may be suffering from CHD though not yielding to death. No one is certain as to how many seafarers are disabled due to CHD and as to how many retire prematurely due to CHD. In the UK, CHD was the commonest reason for refusal at seafarer medical examinations i.e. 24% in 1994 compared to 18% in 1993(British Chamber of Shipping 1994). It is difficult to conduct large studies examining this important issue as data are sparsely available, and thus, there is a lack of knowledge in this important area. Those who argue against a CHD risk for seafarers thrive on the results of studies giving varying mortality rates and relative risk figures though they are inconsistent. Results based on mortality studies may be the "the tip of the iceberg", as they are the only indicators available and some computed from small sampled studies. Therefore, it is fair to comment that risk of CHD among seafarers remains an unknown issue due to the difficulties involved in conducting proper research. If firm conclusions are to be made it will be extremely important to examine the results of both mortality and morbidity studies, an arduous task.

Another objective of this study was to examine the CHD mortality experienced by two ethnic groups of seafarers. However, as the current research exercise was faced with limitations, which were beyond control, the results generated were restricted to PMR computations in the UK and the unadjusted (for age and smoking) mortality rates in India. Major limitations faced with were the lack of denominator data in some situations to compute mortality rates and the lack of age profiles and smoking status data, so that no age adjustment or adjustment for smoking status was possible in both instances of computing PMRs and rates. It was possible to compare the proportions of CHD deaths between the two ethnic groups of seafarers. The proportion of death on board due to CHD among British seafarers was significantly higher (Chi^2 - 5.37; $p<0.05$) than that of Indian seafarers. This finding was consistent with the findings of Roberts (1998) in his mortality study of British, Singapore and Hong Kong seafarers. The mean age at death on board, of British seafarers, was 53.3

while the Indian seafarers succumbed to death on board at a mean age which ranged from 46.44 in 1989 to 52.64 in 1993 during the study period (1985 - 1994). No comments can be made on the mortality rates as mortality rate in the UK was computed with the use of data on the deaths on board only as the numerator and the estimates of the seafaring population as the denominator while rates in India were crude rates computed from more complete data sets. PMRs were available only in the UK. Coronary heart disease remained the major cause of natural deaths on board British and Indian ships, being 91% and 78% respectively.

Many factors have been blamed as risk factors for causing CHD. The identification and modification of these risk factors have been areas of intense investigation and effort. However, the contribution of known major risk factors (advanced age, male gender, hypertension, elevated cholesterol level, smoking, physical inactivity, and type II diabetes mellitus) does not explain a significant fraction of cases of coronary artery disease (Fine and Rosenstock 1994). Research during the last 40 years has established that a limited number of occupational chemical exposures directly cause or substantially contribute to coronary artery disease. In the last decade, there has been an increased interest in the possibility that other aspects of work, such as shift work or work with high demands but in which the worker has little control or influence over how the work is performed, may be additional causal or contributing factors for CHD.

The unique stressors experienced by seafarers are well known. They are exposed to some hazards rarely encountered in other occupations, including unstable platforms, extremes of weather, as well as more widespread hazards such as mobile mechanical equipment and toxic cargoes (hansen 1996). Also, at sea there is no direct access to qualified medical assistance to handle accidents or serious illness. Further, where CHD is concerned, forms of occupational stresses not experienced in any other industry may be playing a major role in causing the illness. Unusual working hours, monotony of long voyages and watch keeping, being away from home and family, frustration due to lack of leisure facilities and normal sexual activity, smaller working

community in modern ships, working with employees from different nationalities, and certain other factors particular to this unusual working and living environment are some of the possible stressors experienced by seafarers. Future research should also attempt to correlate these occupational and psychosocial stressors with CHD among seafarers.

BIBLIOGRAPHY

Berger, M. 1983. Final report on Port Philip sea pilots. No.3. Technical report, Department of Psychology and Brain - Behavioural Institute, Latrobe University.

Brandt, L.P.A et al. 1994. Mortality among Danish Merchant Seamen From 1970 - 1985. American Journal of Industrial Medicine 25, pp.867-876.

British Chamber of Shipping, 1994 . Digest of accident and health statistics pp.17.

Brown, W.D. 1990. Prevalence of hyper cholesteroloemia in a Maritime population. Jr. of occupational Medicine 32(7), pp.612-615.

Carel, R.S. et al. 1990. Occupational stress and well- being: Do Seafarers harbour more health problems than people on the Shore?. Department of Occupational Medicine, Soroka Medical Centre, Israel 26(11), pp.619-624.

Coggon, D. et al. 1995. Occupational mortality by cause of death. In: Drever F, ed. Occupational Health: Decennial Supplement. London: Office of Poulation Censuses and Surveys, H and SE pp.62-76.

Cooper, G.L. and Sutherland, V.J. 1987. Job stress, Mental health and Accidents among offshore workers in the oil and gas extraction 29(2)pp.119-125.

Coronary heart disease 1990. In: Cheltin MD, Sokolow M, Mcllroy MB, eds. Clinical Cardiology. Connecticut: Lange pp.147.

Department of Health, 1994. On the state of public health 1994. London HMSO pp.239-249.

Diseases of the cardiovascular system, 1995. In: Edwards CRW, Bouchier IAD, Haslett C, Chilvers ER, eds. *Davidson's Principle and Practice of Medicine.* Edinburgh: Churchill Livingstone (7th Ed.), pp.245-247.

Dyre-Smith, M.B.A. and Stein, M. 1993. Human resourcing in the European Marine Industry. Revue European de Psychologie Applique, 43(1), pp.5-10.

Ejsmont, E. 1961. Influence of hot work on the circulatory system of workers in ship engine rooms. Builetyn Institute Medycyny Morkkiej W Gdansku 12(1-2), pp.87-140.

Elderly people 1993. In: Donaldson RJ, Donaldson LJ, eds. Essential Public Health Medicine. London: Kluwer Academic Publishers pp.357 - 387.

Filikowski, J. 1989. Change in the State of Health of Seaman induced by their working environment. Bulletin of the Institute of Marine & Tropical Medicine-Gdynia 40(1-2), pp.41-49.

Fine, L.J and Rosenstock, L. 1994. Cardiovascular disorders. In: Rosenstock L, Cullen M, eds. Textbook of Clinical Occupational and Environmental Medicine. Philadelphia: W B Saunders pp.389-400.

Gupta, R. and Gupta, L.P. 1993. An eight year review of diseases in rural Rajastan. Journal of the Association of Physicians of India 41(11), pp.711-712.

Hammar, N. 1992. Alfredsson L, Smedberg M, Ahlbom A. Difference in the incidence of myocardial infarction among occupational groups. Scand J Work Environ Health (18), pp.178 - 185.

Hansen, H.L. 1996. Surveillence of deaths on board Danish merchant ships, 1986 - 93: Implications for prevention. Occupational and Environmental Medicine 53, pp.269-275.

Harrington, J.M. 1972. Mortality from coronary heart disease of English channel pilots and Hamburg pilots. Trans. Soc. Occup Med 22, pp.19-22.

Hellesoy, O.H. 1985. Work environment Statfjord Field Bergen. Oslo: Universitetsforlaget

Japsen, J.P. 1991. Work Environment and Health in the Maritime Occupation. Nortisk Medical 106(11), pp.301-304

Jinzhong, W. 1991. Disease and Accidents among Seafarers; experience from China. Bulletin of the Institute of Maritime & Tropical Medicine. Gdynia 42(1-4), pp.5-9.

Johnson, B.D. et al. 1994. Job stress, social support & health among shrimp fisherman. Work & Stress 8(4), pp.343-354.

Kelman, H. and Kavaler, F. 1990. Mortality pattern of American Merchant seaman 1973-78. American Journal of Industrial Medicine, pp.423-433.

Kilbom, A. 1969. Lostar Och Lostsningsarbete. Arbestsmed Institute. Stockholm. In A.W. Parker, et., al. (1909). A review of Health, Stress & Fatigue in off-Shore maritime workers. School of Human Movement studies. QUT Brisbane, Australia

Kliz, J. et al. 1990. The Use of submaximal Exercise Stress Testing in early detection of Ischaemic Heart Disease in Seaman. Institute of Maritime and tropical Medicine, Gdynia 41(1-4), pp.37-45.

Levy, S. 1972. A study of medical causes of absence from duty aboard South African merchant ships. british Journal of Industrial Medicine 29, pp.196-200.

Lopez, L.D. 1990. Who dies of what? A comparative analysis of mortality conditions in developed countries around 1987. World Health statistics Quarterly 43(2), pp.105-114.

Moss, A.J. 1991. Epidemilogy of sudden cardiac death. In: Bayes De Luna A et al., Eds. Sudden Cardiac Deaths. Dodrecht: Kluwer Academic Publishers pp.13-17.

Nakamura, F. 1973. Health status of ocean going oil tanker seaman. Bulletin, Tokyo Med. Dept. University 20, pp.221-244.

Offer-Ohlsen, D. 1981. Seamen signed off owing to injuries and disease in the Norwegian Merchant Fleet, 1979 - 81, Norsk bedr.h.tj. 2,pp.150-152.

Ohashi, N. and Hirota, Y. 1969. The Mental Strain of Ship-Manoeuver. XVI. International Congress on Occupation Health. Tokyo, Japan, Sept. pp.22-27.

Ohashi, N. and Sugihara, Y. 1976. In A.W. Parker, et., al.(1992). A review of health, stress and fatigue in offshore maritime workers. School of Human Movements Studies, QUT Brisbane Australia.

Olsen, O and Kristensen, T.S. 1991. Impact of work environment on cardiovascular disease in Denmark. J Epidemiol Community Health 45,pp.4-9.

Proceedings of a research workshop on fatigue in the maritime industry 1996. Seafarers International Research Centre for Safety and Occupational Health, University of Wales, Cardiff, April, pp.17

Rafnsson, V and Gunnardottir, H. 1994. Mortality among Icelandic seamen. International Journal of Eoidemiology 23(4),pp.736.

Roberts, S. 1997. Mortality among seafarers on the British Merchant Fleets (1986 - 1995): findings from an ongoing research study. An interim report published by the Seafarers International Research Centre, University of Wales Cardiff, pp.34

Roberts, S. 1998. Occupational mortality among merchant seafarers in the British, Singapore and Hong Kong Fleets 1981 - 1995. Report published by the Seafarers International Research Centre, pp.29.

Rodahl, K. 1989. Stress at Sea. In Rodahl. K (Ed). The physiology of work. Taylor & Francis. London, pp.207.

Rumyantsev, G.L and Mekhel'son, D.A. 1972. Effect of noise and vibration on seaman. Hygiene and sanitation 36(9), pp.356-359.

Steward, J.P. 1990. Occupational Stress, Chap. 35. In LaDou,J. (Ed). Occupational Medicine. Appleton & Lange, Connecticut pp.104 - 107..

Study for early identification of circulatory diseases among seamen by MRI (1995). Marine Medical Research Collection. The Seamen's Insurance foundation, Japan pp.744.

The World Health report 1996 (1997). Fighting disease Fostering development. WHO, Geneva pp.75-76.

Thomaszewski, R. et al. 1990. Studies on the risk of Ischamic heart disease in fisherman, Seafarer & Docker. Bulletin of the Insitute of Maritime and Tropical Medicine, Gdynia 41(1-4), pp.21-26.

Thomaszunas, S and Mrozi Ski, W. 1990. Desease and injuries in Polish seafarers repatriated from ships Bulletin of the Institute of Maritime and Tropical Medicine. Gdynia 42(1-4), pp.11-16.

Tunstall-Pedoe, et al. 1994. Myocardial infarction and coronary deaths in the WHO Monica project. Circulation 90(1), pp.586-587.

Urner, C.J. 1991. Medical care at sea: A ten year overview of treatment aboard and on shore. In: Gardner AW, ed. Proceedings of the International symposium on Maritime Health. Turku, pp.209-243.

Vukeli, M. et al. 1989. The influence of noise on blood pressure in Seaman on sea going vessels. Bulletin of the institute of Maritime Tropical Medicine, Gdynia, 40(3 - 4), pp.151 - 162.

Waskiewicz, J. 1991. Maxiamal Oxygen uptake in dockers performing heavy work and in operators of Mechanic equipment in habour. Bulletin of the Institute of Maritime & Tropical Medicine, Gdynia, 42(1-4), pp.57-65.

Waskiewicz, J. 1992. Assessment of graphical phonocardio investigation among Seafarers. Bulletin of the Institute of Maritime & Tropical Medicine. Gdynia 43 (1-4), pp.61-67.

Yokayama, T. et al. 1974. Temporary thresholds shifts produced by exposure to vibration, noise & vibration plus noise, Acta Oto Laryngologica 78, pp. 3-4.

Zorn, E.W. et al. 1997. Ischaemic heart disease and work stress in West German Sea Pilots. Journal of Occupational Medicine 19(11), pp.762-765.

Appendix I

Crude Moratlity Rates Of Indian Seafarers (by Different Job Categories)

	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	n	%
Deck Officers	0	221.9	80.4	40.1	1193.0	39.9	0	34.7	29.9	51.7	51.7	23.5	18	2.82
Engine Officers	143.3	0	68.9	34.3	68.2	34.2	0	0	0	22.2	0	0	10	1.60
Petty Officers	289.8	0	630.9	471.7	156.3	156.4	0	0	117.1	0	199.6	192.1	16	2.51
Deck Ratings	1173.7	1531.0	939.7	1568.8	688.4	1015.9	482.3	441.6	136.0	226.5	71.4	31.3	293	45.92
Engine Ratings	780.3	1427.3	989.0	583.7	543.5	290.3	418.0	63.1	135.9	56.6	124.9	53.4	149	23.35
Catering Ratings	738.9	1334.6	729.7	729.7	688.2	471.5	385.7	189.3	54.4	132.1	35.7	71.2	152	23.82
Total (n)	91	121	99	84	59	52	40	23	14	25	17.0	13.0	638	
%	14.26	18.96	15.52	13.17	9.25	8.15	6.3	3.61	2.19	3.91	2.66	2.04		