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# WORK, STRESS AND CIGARETTE SMOKING AS PREDICTORS OF CARDIOVASCULAR ACTIVITY IN FEMALE NURSES

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MSc. Thesis  
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## ABSTRACT

Previous studies have shown that work stress can cause an increase in blood pressure (BP) and in some case heart rate (HR), relative to home measurements. It has been suggested that elevations in BP and HR may increase risk of cardiovascular disease (CVD), the primary cause of morbidity and mortality for women. It is also thought that premenopausal women show lower BP and higher HR responses to stress than other demographic groups, because of the effects of oestrogen. A recent laboratory study has suggested that women who smoke cigarettes may increase their CVD risk, partly because of a decline in their oestrogen levels as a result of smoking. Thus women who smoke may show different BP and HR responses than non-smokers. The aims of the study were firstly to investigate the effects of work and stress on BP and HR in working women, and secondly to explore whether these effects were different in smokers and non-smokers.

A group of 38 female nursing staff participated in a 24-hour period of ambulatory BP and HR monitoring which included one daytime work shift. Reported mood, perceived busyness and control over their activity, posture, location, activity, smoking behaviour and intake of food and drink were recorded in diaries during the monitoring period.

It was found that work ambulatory BP and HR were significantly higher when compared with home measurements. Smokers (N = 9) did not demonstrate differences in their cardiovascular responses when compared with non-smokers.

# **Work, stress and cigarette smoking as predictors of cardiovascular activity in female nurses**

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September 2001



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## CHAPTER ONE – INTRODUCTION

Cardiovascular disease is the primary cause of morbidity and mortality for women living in industrialised societies (Kannel and Abbott, 1987). Although recognised as the major cause of death in men, only in more recent years has it been highlighted as a significant health issue for women. Research has focused on cardiovascular risk in men, whose onset of disease is some 10-15 years earlier than that of women (Lerner and Kannel, 1986; Castelli, 1988). The recognition of the importance of this condition in both sexes, has led to a call for women to be included in clinical trials (Gurwitz et al., 1992; Wenger et al., 1993; Hamilton, 1996).

The ability to measure cardiovascular activity in an everyday environment has demonstrated the role that blood pressure and heart rate may play as predictors of cardiovascular disease (CVD) (Schnall et al., 1990). Sustained high blood pressure (hypertension) is a major risk factor for CVD (Stokes et al., 1987; Kannel, 1996). It has been suggested that repeated elevations of blood pressure (BP) and heart rate (HR) may increase risk of CVD (Obrist, 1981; Manuck and Krantz, 1986; Manuck et al., 1990). Ambulatory BP and HR monitors, which can measure such variation in everyday life, are well-established research tools in the field of cardiovascular health (Pickering et al., 1991; Schnall and Belkic, 2000). They are automatic portable devices, designed to be worn throughout the day and night, whilst recording cardiovascular activity at regular intervals (Pickering et al., 1985).

Investigations of stressors (factors inducing perceived stress) in daily life have measured cardiovascular activity with ambulatory monitors and correlated data with changes in activity, perceived stress, mood and behavioural factors such as cigarette smoking (James et al., 1986). Studies in the workplace have shown increases in blood pressure in response to job stress (Pickering et al., 1991; Kamarck et al., 1998; Schnall et al., 1994; James and Bovbjerg, 2001; Pollard, 2001).

Recognition of the role of stress in cardiovascular disease risk (James et al., 1987; Philipp, 1987; Schwartz et al., 1996) has led to studies that suggest that oestrogen may affect women's stress responses in a way which may be cardio-protective (Girdler et al., 1997). Measuring cardiovascular responses in men and women has highlighted gender differences in their physiological responses when stressed (Girdler and Light, 1994; Girdler et al., 1997). The suggestion that oestrogen may have a role in these differences is further strengthened by studies of pre and postmenopausal women (Matthews, 1989; Saab et al., 1989).

Of further interest, is that women who are smokers have been shown to produce responses to stressors that are more akin to the physiological responses of men (Girdler et al., 1997). Studies have indicated a relationship between cigarette smoking and oestrogen decline and deficiency (Lesko et al., 1985; Michnovicz, et al., 1986, Meek and Finch, 1999). Women who smoke may therefore increase their susceptibility to cardiovascular disease prematurely.

The aim of this thesis is to examine factors that may affect blood pressure and heart rate variation in women during their daily lives. Nurses are of particular interest as a group because they often experience substantial job stress (Dewe, 1987; Fox et al., 1993; Glass et al., 1993). This study was designed to investigate the effect of stress caused by work on ambulatory blood pressure and heart rate in nurses, and to determine whether there were differences between smokers and non-smokers. Firstly, a review of the literature is presented in Chapter Two. In the following Chapters (Three and Four), the aims and design of the study and a profile of the study participants and methodology are described. Subsequent chapters are devoted to the presentation of results and a discussion of these findings.

## CHAPTER TWO – A REVIEW OF THE LITERATURE

This Chapter presents the relevant research constituting the background to the thesis. The importance of cardiovascular disease in women is demonstrated initially, and the role of oestrogen in protecting women from CVD is discussed. The significance of ambulatory BP and perhaps HR, for CVD risk is outlined and then the main body of this review considers the effects of work and mood on BP and HR. Special consideration is given to women's BP and HR responses and how they may be moderated by the effects of oestrogen. Finally the role of smoking in moderating women's BP and HR responses to work stress, perhaps through its effects on oestrogen levels, is considered.

### **1. Cardiovascular disease in women**

Cardiovascular disease (CVD) is the major cause of death in women from industrialised societies (Brezinka and Padmos, 1994; Weidner, 1994). It is a term that describes the diseases of the vascular system of which coronary heart disease (CHD) is only one aspect. Other manifestations of CVD are hypertension (high blood pressure), left ventricular hypertrophy (enlargement of the left ventricle of the heart) and cerebrovascular disease (stroke). Risk factors for CVD are associated with western lifestyle (Trowell and Burkitt, 1981).

Mortality figures for North American men and women demonstrate that it is the most common cause of death (U.S.Bureau of Census, 1991) and that more

men die from CVD than women (Wingard, 1984; Lerner and Kannel, 1986). Despite this women have been found to have a poorer prognosis than men regarding early death post myocardial infarction (Lerner and Kannel, 1986; Greenland et al., 1991), and following surgical procedures such as coronary artery bypass and angioplasty (Loop et. al, 1983; Bell et. al, 1993).

Every year some 2.5 million North American women are admitted to hospital with CVD and approximately 500,000 die of the disease. Half of that number dies from CHD (American Heart Association, 1992). Research from England has been compared with that of the United States (US) (Wenger, 1998), where lifestyle is similar. US statistics for CHD in premenopausal women however are very low, with an average annual incidence rate of 1 per 1,000 women age range 35-44 years and 4 per 1,000 women age range 45-54. Prevalence of CHD is therefore very low in young and middle-aged women (Kannel and Abbot, 1987; Wenger et al., 1993).

It is thought that women have been excluded from CVD clinical trials because of their differences to men during childbearing years and pre-existing illnesses during old age (Gurwitz et al., 1992). Lack of research data relating to CVD in women has highlighted a need for further exploration of these issues (Tobin et al., 1989; Ayanian and Epstein, 1991).

## 1.1. Oestrogen and cardiovascular risk

Studies of the menopause and CVD have demonstrated that female hormones offer women some protection (Colditz et al., 1987). Onset of CVD generally occurs some 10-15 years earlier in men (Castelli, 1988). Cessation of oestrogen production takes place during menopause, when the ovaries stop producing ova. The significance of oestrogen hormones can in part be appreciated by the many consequences of their decline.

After menopause, reduction in oestrogen increases the possibility of deposition of cholesterol in blood vessels and may contribute to the rise in incidence in heart disease in postmenopausal women (Griffiths, 1994). Research involving women taking hormone replacement therapy (HRT) has shown a reduction of plasma viscosity and plasma fibrinogen (Frohlich et al., 1998) and a delay in formation of atheroma (plaque) (Hough and Zilvermit, 1986). HRT may reduce the likelihood of atheromatous plaques breaking up through its action on blood lipids and vessel walls, therefore lowering the risk of CVD (Sullivan, 1996).

Compared with postmenopausal women and men, premenopausal women have increased lipoprotein and carbohydrate metabolism due to the presence of oestrogens, which also convey a beneficial effect on clotting factor regulation (Knopp et al., 1994; Schenck-Gustafsson, 1996). Studies of lipid profiles have shown that they also have lower levels of low-density lipoprotein (LDL) cholesterol and total cholesterol. After menopause LDL levels rise

beyond those of men (National Cholesterol Education Program, 1993; Schenck-Gustafsson, 1996). Increased blood levels of high-density lipoproteins (HDL) in premenopausal women (when compared with postmenopausal women and men), are attributed to the oestrogen oestradiol-17 $\beta$  and are thought to be protective against arteriosclerotic disease (Fahraens et al, 1982). Although HDL levels are reduced after menopause, they continue to be higher than those seen in men (National Cholesterol Education Program, 1993).

Not only does oestrogen have a favourable effect on blood composition and lipid profile, but it also has beneficial effects on arterial walls. Animal studies have shown that oestrogen is responsible for a reduction in platelet aggregation and deposition of fat on the arterial wall. It reduces the tendency of blood vessel muscle cells to multiply (Fischer et al., 1977; Beldekas et al., 1981). As a consequence of this, there is a slower progression in the changes in arterial walls (thickening, loss of elasticity) (Williams et al., 1990), which lead to an increase in BP. Analysis of the coronary angiograms of over nine hundred women showed significantly less coronary disease in the 16 % of women taking oestrogen at the time, or within three months of the study (Gruchow et al., 1988). Oestradiol-17 $\beta$  can also improve blood flow by causing vasodilatation. Studies have shown administration of oestradiol-17 $\beta$  has led to increased arterial blood flow and decreased peripheral vascular resistance (Reidel et al., 1995; Volterrani et al, 1995). Postmenopausal women taking oestradiol (oral and transdermal) have shown a significant reduction in ABP

when compared with their controls (Mercuro et al., 1998; Van Ittersum et al., 1998).

There is a body of evidence to support the prescribing of oestrogen (with progesterone in the form of hormone replacement therapy) in the primary prevention of CVD (Stampfer et al., 1991; Grady et al., 1992; Barret-Connor, 1997; Mendelsohn and Karas, 1999) for postmenopausal women. Despite this the American Heart Association (2001) has very recently revised the guidelines and advised against the use of HRT as a means of primary prevention in postmenopausal women (Mosca et al., 2001). The basis of this decision is thought to be due to conflicting evidence regarding treatment (Josefson, 2001).

#### **1.1.1. Variation in ovarian function**

Average oestrogen levels in women are thought to vary between populations and to have increased due to modernisation. Some of the reasons for this may be biological processes related to physical workload, parity, and dietary intake (Ellison et al., 1993). Factors which affect ovarian function and consequently oestrogen levels, are thought to be related to calorie intake and total energy output (Ellison et al., 1993). Differences may arise as a result of personal choices regarding exercise and diet (Ellison et al., 1993; Rosetta et al., 1998). They may also be a consequence of cultural differences in diet (Key et al., 1990) or ecological and environmental determinants such as occur in subsistence populations (Ellison et al., 1993; Panter-Brick et al, 1993).

In industrialised societies calorie intake is more often high in comparison to that of developing populations. The association between obesity and increased oestrogen levels in women (Ellison, 1984) may go some way to explain differences in oestrogen production between populations. Although oestrogen is predominantly produced in the ovaries, other sources may be found in larger amounts in adipose tissue (Martin, 1976). Extragonadal oestrogen in the peripheral tissues is thought to be as high as 40% of the circulating levels for premenopausal women (Kirschner et al., 1982; Ellison, 1984).

Physical stressors responsible for a reduction in ovarian function in women from industrial populations usually take the form of recreational exercise or reduced calorie diets (Ellison, et al., 1993). Such stressors can be modified by individuals and therefore are regarded as lifestyle factors affected by behaviour (Ellison et al., 1993). Cigarette smoking, a lifestyle behaviour, has also been shown to effect oestrogen production in premenopausal women and be related to early menopause (Adena and Gallagher, 1982; MacMahon et al. 1982; Lesko et al., 1985; Michnovicz, et. al., 1986, Meek and Finch, 1999).

Studies investigating the effects of smoking on oestrogen and menopause have indicated a relationship between oestrogen decline or deficiency and cigarette smoking (Lesko et al. 1985; Michnovicz, et. al., 1986, Meek and Finch, 1999), however not all research has found this link (Khaw et al., 1988; Key et al., 1991). The possible anti-oestrogenic effect of cigarette smoking (Baron, 1990) is also thought to have an effect on blood cholesterol levels which have been found to be raised in several studies (Goldbourt and Medalie, 1977; Schoenenberger, 1982; Elkeles et al., 1983). For women who smoke

risk is also increased for osteoporosis (Weiss et al., 1980; Kiel et al., 1992), however it is lower for breast and endometrial cancer and these findings are postulated to be related to the effects of oestrogen (Vessey, et al., 1983; Lawrence et al., 1987).

## 1.2. Smoking and cardiovascular disease

Cigarette smoking is now known to be a major risk factor for CVD (Willett et al., 1987). Cardiovascular risk for women who have smoked low-yield cigarettes believing them to be safer (Silverstein et al., 1980) has been found to be similar to that of women who smoke brands which are higher-yield (Palmer et al., 1989; Rosenberg et al., 1990). BP and HR have been noted to rise acutely in response to smoking, increasing the oxygen demands of the heart muscle (Klein, 1984). A recent study of American nurses found that smoking had a significant effect on HR (Morgan et al., 2001). Smoking also increases the risk of stroke (Bonita et al., 1986), but despite these findings there is as yet no evidence of a direct causative link between cigarette smoking and hypertension (Bittner and Oparil, 1993). The relationship between cigarette smoking and hypertension remains unclear, however smoking is an independent and significant risk factor for CVD (U.S. Dept. of Health and Human Services, 1983; Willett et al., 1987). Rosenberg et al.'s (1990) study of myocardial infarction risk in women who had stopped smoking, concluded that increased risk for both men and women gradually recedes and usually returns to normal risk after two to three years. Smoking is therefore of particular

interest in this study, not only because it is a major risk factor for CVD, but mainly because of its effects in reducing oestrogen levels.

Since the early twentieth century, the industrialised West has seen an increase in the number of women who smoke. Smoking is now in decline, although the rate of decline for women is less than that of men. There is now little difference in the number of male and female smokers, although in the past two decades, rates for adolescent females have been increasing (Sorensen and Pechacek, 1986; Biener, 1987). In a study by Diamond and Goddard (1995) in 11-15 year old children, more girls were found to be regular smokers than boys were over the period 1986-1994. A report on the health of people in Teeside in 1995 has found a higher percentage of female smokers than male in all age groups under 75 years (15-24, 25-44, 45-64 and 65-74 years) (Cleveland Health and Lifestyle Survey, 1995). From projected figures for the years 1990-2000, it is thought that for the first time in some industrialised countries, more women will be cigarette smokers than men (Fiore, 1994).

Smoking women in industrialised countries are therefore likely to have smoked over the whole of their reproductive lifespan. Not only is there a trend to commence in adolescence, but there is evidence that women find giving up the behaviour more difficult than men (Biener, 1987).

## 2. Blood pressure and heart rate

### 2.1. Ambulatory blood pressure and heart rate as a risk factor for CVD

Results from the Framingham study showed that hypertension is a major coronary risk factor (Stokes et al., 1987). Having hypertension increases the risk of developing significant cardiovascular events (such as myocardial infarction or angina pectoris) by two or three times, although this is likely to be dependent on treatment (Kannel, 1996; Padwell et al., 2001). In comparison to men, blood pressure is thought to be lower in women, prior to menopause (Cornoni et al., 1989; American Heart Association, 1992), however over the age of 65, more women have been found with hypertension than men (Anastos et al., 1991).

Only in 5% of cases of hypertension can a cause be found. The remaining 95% of cases are ascribed to "essential" hypertension (due to no known cause) (Bittner and Oparil, 1993). The effects of hypertension are seen in the development of left ventricular hypertrophy (LVH), a result of the heart working harder to pump blood against an increased arterial pressure. LVH is a risk factor for CVD (Kannel and Belanger, 1991). Hypertension is a major risk factor for stroke in both men and women because of higher pressure inside the vessel walls (Kannel et al., 1970).

Blood pressure and HR vary in response to changes in our daily environment. Certain psychological and physical factors associated with an individual's

environment, such as mood, hostility and physical activity, have been found to induce acute increases or fluctuations in BP and HR (Jamner et al., 1991; Schwartz et al., 1994). It has been suggested that repeated increases in BP and perhaps HR, may be contributing factors toward the development of hypertension (Obrist, 1981; Manuck and Krantz, 1986; Folkow, 1989) and CHD (Manuck and Krantz, 1984). Elevations in HR have also been found to increase formation of atheroma (Kaplan et al., 1987). The role that psychosocial factors play in the development of hypertension is however, not established and researchers continue to assess the evidence for this (Schnall et al., 1994; Schwartz et al., 1996; Theorell and Karasek, 1996).

Studies have measured BP and HR changes during daily life using ambulatory blood pressure monitors (James et al., 1993, Pickering et al., 1991). Preference for their use as a research tool in the field and in laboratory settings is because they are thought to give readings more representative of normal daily variation than conventional methods of measurement (Pickering et al., 1991). Schnall et al.'s (1994) review of cardiovascular disease and job stress found that studies using ambulatory blood pressure (ABP) measurements were more likely to produce significant associations between BP and work stress than studies using clinic measurements.

## **2.2. Blood pressure, heart rate and stress**

The concept of stress has been described as a perception of an inability to cope in the face of certain demands (Lazarus, 1966; Lazarus and Folkman,

1984). In a situation of stress or threat, the sympathetic nervous system is activated resulting in secretion of adrenaline from the adrenal medulla, and pituitary stimulation causes the release of steroid hormones from the cortex. Raised levels of these hormones result in cardiovascular changes such as increases in heart rate and blood pressure (Friedman and Rosenman, 1974; James et al., 1989; James and Brown, 1997).

Researchers have explored the effects of reported stress on BP and HR in order to determine any links or pathways with regard to CVD. Both in the laboratory (Feldman et al., 1999) and in the field (Pickering et al., 1991; Kamarck et al., 1998; James and Bovbjerg, 2001; Pollard, 2001), studies have demonstrated an increase in BP and HR in response to stressors. The study of BP in daily life has raised the question of whether perceived stress is an important contributing factor in the aetiology of CVD (Pickering et al., 1991) and has given rise to the idea that workplace stress may be of particular relevance.

### **2.2.1. Blood pressure, heart rate and work stress**

Exploration of work stress has been ongoing since the 1960's, when working conditions and disease processes were initially the focus of research (Buell and Breslow, 1960). Although not replicated by all such research (Kennedy et al., 1983), the findings of several studies have demonstrated higher ambulatory blood pressure (ABP) measurements recorded at work than in the

home environment in both men and women (Clark et al., 1987; Gellman et al., 1990; James et al., 1993; James and Bovbjerg, 2001).

The demand-control model examined job strain in relation to illness and CVD (Karasek et al, 1981). Karasek (1981; 1990) and his colleagues suggested that the most stressful, 'high strain', jobs are those combining high demand with low control, drawing on the earlier ideas of Frankenhaeuser and Gardell (1976) who had investigated the issues of lack of control and workload. The job strain model (Karasek, 1979; Karasek et al., 1981; Karasek and Theorell, 1990) was initially tested in a large-scale survey of Swedish and American males occupying high strain jobs. The effects of job strain were measured in relation to both psychological and physical health. An association was found between high strain occupations and cardiovascular disease in men (Karasek et al., 1981; Karasek et al., 1988).

Other researchers demonstrated the effects of job strain in both men and women within the workplace (Haynes, et al., 1987; McInaney and Hurrell, 1988; Warr, 1990; Pollard et al., 1996). Schnall et al.'s (1994) review of the evidence relating job strain to CVD found that the majority of published studies they examined showed a significant relationship between job strain and CVD. Theorell and Karasek's (1996) comments and further expansion of that (Schnall et al., 1994) examination, concluded that job strain was associated with cardiovascular mortality and morbidity in more than half (16 out of 22) of the studies reviewed.

Stimulated by research which examined job strain and CVD, were other projects investigating BP at work using ambulatory blood pressure monitors. The examination of almost 200 American men working in seven separate organisations, established an association between high strain occupations and high ABP. In this case-control study, subjects were also assessed by echocardiogram. The authors found that left ventricular hypertrophy (enlargement of the left ventricle of the heart) was associated with mean work ABP (Schnall et al., 1990).

Longitudinal research for the Framingham Heart Study has shown women to be at greater risk of developing CVD over a 10 year period whilst occupying high strain jobs in comparison with other types of work (Haynes et al., 1987; Lacroix and Haynes, 1987). More recent work investigating the affects of psychosocial factors in the workplace on self-reported cardiac disease (Bosma et al., 1997), concluded that lack of control at work was related to an increase in CHD risk (newly reported CHD events) for both sexes. This increased risk for those who had low control in the workplace, was almost double that (odds ratio of 1.93) of individuals who exercised high control over their work situation (Bosma et al., 1997).

Prior to the 1980's, research concerning stress in the workplace and its effects on health usually involved only the study of men (Karasek, 1979; Karasek et al., 1981; Frankenhaeuser and Johansson, 1986). Only the inclusion of women in such research raised the question of whether their BP responses to work stress may be different to those of men. Frankenhaeuser et al.'s (1989) study

of male and female Volvo workers highlighted sex differences in responses to work stress. Whereas perceived stress at work was correlated with a rise in systolic and diastolic blood pressure in men, in women this pattern was not replicated. However, women who perceived work as stressful also reported high levels of home stress, unlike the experience of men, who were able to 'unwind' at home (Frankenhaeuser et al., 1989).

Having established that women may react differently to stress than men, it was appropriate to look in more detail at studies in women, which although fewer in number, are more relevant to this thesis.

Women are thought to have a different experience of stress at home than men, because of their domestic commitments. Gender differences in workload within the family have been found in a longitudinal study of 200 working female professionals with young children. Those who combined work with the role of childcare were thought to have chronic role stress that impacted on both their home and work environments (Wortman et al., 1991). Wortman et al. (1991) described this stress as 'spillover', which affects other roles.

A study of 121 female workers which examined stress in the home and at work found that women who perceived more stress in the workplace had significantly raised systolic and diastolic ABP, from 9am – 6pm, in comparison to those who reported more stress at home (James et al., 1991). Perceived stress appeared to have a significant effect on ABP responses. A similar study investigating the effects of age and perceived stress on ABP responses of

women working in New York, found significantly higher systolic and diastolic ABP measurements at work in comparison to home (James and Bovbjerg, 2001). Thus, while women have sometimes been observed to show elevated BP at work compared to home, in a similar way to men, sometimes their workload at home may mean that they show a different pattern to that of the average man.

#### **2.2.1.1. Nurse stress at work**

Studies of nurses have demonstrated high levels of reported stress (Calhoun, 1980; Ivancevich and Matteson, 1980). Stress is inherent in their work, not only because of its varied demands, but also due to pressures to provide a service under imposed financial constraints (Dewe, 1987). The predominance of women in the nursing profession (Goldstein et al., 1999) has resulted in many studies being exclusively about women (Tagliacozzo and Vaughn, 1982; Doncevic et al., 1988; Broege et al., 1997; Brown et al., 1998; Goldstein et al., 1999; Reise et al., 2000; Morgan et al., 2001). Studies inclusive of men have reported few male participants in their samples (Numerof and Abrahams, 1984; Dewe, 1987; Landeweerd and Boumans, 1988; McLaney and Hurrell, 1988).

Attempts have been made by researchers to identify situations perceived by nurses as being stressful (Gray-Toft and Anderson, 1981a; 1981b). A study by Dewe (1987), supported earlier research by Gray-Toft and Anderson, (1981a; 1981b) and identified five common potential stressors. These were: heavy workload, problems with staff, nursing critical patients, nursing helpless and

difficult patients and concerns regarding the treatment of patients (Dewe, 1987).

Certain areas of work have been found to be more demanding and therefore more stressful for nurses. Numerof and Abrahams (1984) found that nurses reported high stress levels on their Nursing Stress Inventory Scale from all units, but that the psychiatric, surgery and medical wards were particularly stressful work areas.

A study of job satisfaction in 675 Canadian nurses testing four elements of control in the workplace and three different work stressors, found that demand and control had a direct effect on job satisfaction (McLaney and Hurrell, 1988). Having control at work however, did not decrease the effects of job demands as previously proposed by Karasek (1979).

### **2.2.2. Blood pressure, heart rate and mood**

In the last decade some studies involving nurses have also looked at physiological measures in conjunction with factors such as perceived mood (Broege et al., 1997; Brown et al., 1998), home and work (Morgan et al., 2001) and demand and control in the workplace (Doncevic et al., 1988; Goldstein et al., 1999; Brown and James, 2000; Reise et al., 2000). Brown et al.'s (1998) study of Filipino-American and Caucasian nurses and nurse's aides found that reported negative moods were significantly more frequent and intense at work in comparison to home, and that negative moods lead to a significant rise in

systolic and diastolic ABP whilst at work. ABP at work was significantly increased in comparison to home (Brown et al., 1998).

Studies investigating the effects of recurring stress, noted that mood was associated with ABP and HR variation (Kamarck et al., 1998). This study of 120 participants (both men and women) measured cardiovascular reactivity using ABP monitors. Negative mood, arousal, job or task strain and control were recorded on electronic diaries, over the course of six days. High negative affect and high arousal were found to be associated with an increase in ABP and HR (Kamarck et al., 1998).

Changes in BP responses in association with mood have also been noted by other researchers (James et al., 1986; Schwartz et al., 1994; Brown et al., 1998; Jacob et al., 1999) although Schwartz et al. (1994) concluded that mood accounted for only limited variance in BP and HR. An investigation of long-term variation in self-reported mood with BP and cholesterol levels found that systolic and diastolic BP increased during tense arousal, whilst negative affect was associated with an increase in systolic BP (Pollard and Schwartz, submitted).

### **2.2.3. Oestrogen and blood pressure and heart rate responses to stress**

Physiological responses to stress may be different for men and women. Reviews of the evidence have found that in laboratory-based research men, in comparison to premenopausal women, had a larger adrenaline and systolic BP

response when exposed to stress (Polefrone and Manuck, 1987; Stoney et al., 1987).

Measuring cardiovascular stress responses in men and women has elicited other differences between the sexes, which may explain further the protective mechanisms pre-menstrual women appear to have from CVD. When stressed, men increase their blood pressure as a result of raised peripheral vascular resistance, whereas women generally tend to have an increase in heart rate (Girdler and Light, 1994; Girdler et al., 1997). The implication is that oestrogen may be responsible for this difference in haemodynamic stress response (Pines et al., 1991; Girdler and Light, 1994; Girdler et al., 1997). In support of these findings, a meta-analysis of studies investigating physiological responses to acute behavioural stress noted greater HR responses to stress in women when compared with men (Stoney et al., 1987).

Under laboratory conditions, postmenopausal women exposed to behavioural stressors, showed greater increases in systolic BP, when compared with pre-menopausal women (Lindheim et al., 1992). To elicit the effects of oestrogen, the postmenopausal group were divided into those receiving oestrogen treatment (applied to the skin) for six weeks and a placebo group and re-tested. Lindheim et al., (1992) concluded that oestrogen appeared to be the factor that dulled the responses to stress noted in the oestrogen treated group.

These studies have shown that oestrogen may lower systolic BP and increase HR response in women.

### **2.2.3.1. Smoking effects on blood pressure and heart rate responses to stress**

Girdler et. al.'s (1997) more recent work showed significant differences between women smokers and non-smokers. The study demonstrated less reactivity regarding cardiac output and HR, in response to laboratory stressors in women who smoked. The authors also found an increase in peripheral vascular resistance and thus BP, in response to stress in the smoking group of women compared to the non-smoking women (Girdler et. al, 1997). This response was more akin to the way men had responded when exposed to stressors in a laboratory setting (Girdler and Light, 1994). This study suggests that smoking influence's women's response to stress in a way which may increase their cardiovascular risk, and Girdler and Light (1994) suggest this may be because smoking suppresses oestrogen levels.

### **3. Conclusion**

Oestrogen appeared to change the way that the cardiovascular system responded to stress. This difference (increased HR and cardiac output) appears to be lost in smokers (Girdler et al., 1997). This may be a significant issue for women particularly for women from Teeside (Section 1.2.), where women have been found to smoke more than men (Cleveland Health and Lifestyle Survey, 1995). Cardiovascular disease is the major influence on female mortality in industrialised countries. Risk factors for CVD include sustained raised blood pressure and cigarette smoking. Perceived stress and psychosocial factors have been shown to influence the pattern of blood

pressure change and heart rate during daily routine. These changes may be related to the development of hypertension and subsequent CVD. Research has demonstrated that changes in blood pressure, which are thought to occur under stressful conditions, may be moderated by oestrogen and thus lower in premenopausal women. Measurements of ABP and HR may be used to show cardiovascular reactivity in response to the high levels of work stress reported by nursing staff in a hospital setting.

## CHAPTER THREE – AIMS AND STUDY DESIGN

### 1. Aims

The initial aim of the study was to investigate the relationship between stress and cardiovascular activity (BP and HR), and how this relationship differed in groups of women (pre and postmenopausal; smoking and non-smoking) likely to have different levels of oestrogen. However, very few postmenopausal women could be recruited and comparisons with premenopausal women were therefore not possible. The focus of the study was then re-directed to examine the effects of work and stress on BP and HR and to investigate whether being a smoker altered any of these effects.

A review of the literature revealed differences in the home and work experience. This raised the question of what in the work environment caused BP to be higher than it was at home? Studies of control and demand (Frankenhaeuser et al., 1989) and mood (James et al., 1989; Brown et al. 1998), suggest that the demand and reduced control at work contribute to negative mood and may affect BP and HR (Johnston and Anastasiades, 1990). This study will therefore assume that work is the main stressor in the lives of nurses and will seek to determine its effect on BP in this sample, and what it is in the experience of work that may make BP and HR higher than it is at home. Additionally, because this study is interested in how smoking may affect women's BP and HR responses to stress, it will further investigate whether smokers differ in their cardiovascular reactivity. Although such an investigation had been previously carried out in a laboratory (Girdler et al.,

1997), this study would appear to be testing these findings for the first time in everyday life.

## **2. Study design**

The study was designed to test the association between daily psychosocial experience and BP and HR at the within-subject level. In more detail therefore, the aim of the study was to measure BP and HR multiple times throughout one working day and examine associations between changes in the environment and perceptions of the participants, and changes in BP and HR. Some between-subject analyses were also conducted to investigate differences among smokers and non-smokers.

The primary factors investigated were psychological (perceived stress), psychosocial (work and cigarette smoking) and physiological (BP and HR). Other associated factors considered were those that might influence cardiovascular responses. These factors (posture, caffeine, physical activity, mood, busyness and lack of choice) were also included as variables in the analyses at the within-subject level. Analyses at the between-subject level, comparing the responses of smokers with non-smokers, included the factors of age, body mass index and waist and hip ratio.

Because analyses were mainly at the within-subject level, it was not necessary to recruit a large number of participants, but intensive data collection from each participant was a necessity. Within-subject analyses based on self-reported diary data allowed for the repeated collection of information during the

regular measurements of ambulatory BP and HR throughout the monitoring period. Because ambulatory BP (ABP) monitoring is a validated and practical method of measuring cardiovascular activity in the workplace and at home (James, 1991; Pickering et al., 1991; Brown et al., 1998) and an established research tool (Schnall and Belkic, 2000), this was the chosen technique for collecting physiological data (BP and HR).

Anthropometric measurements and the implementation of previously validated questionnaires provided more information for the purposes of this investigation. Data were collected over a period of 24-hours. The study sample was taken from a large district hospital in the North East of England. Because women's health and experiences at work were the focus of the study, an occupational sample of female nurses and health care assistants was recruited.

### **3. Hypotheses**

- Ambulatory blood pressure and heart rate is higher at work than at home.
- Smokers show more blood pressure and less heart rate reactivity at work than do non-smokers.

## CHAPTER FOUR – SUBJECTS AND METHODS

Participant recruitment and characteristics of the final sample are presented here. Methods used to record blood pressure and anthropometric measurements are also described. The questionnaires used and the 24-hour diary are then discussed.

### 1. Subjects and procedure

#### 1.1. Recruitment

Recruitment and data collection took place between September 1999 and March 2000. Prior to recruitment a liaison meeting with Nursing personnel, outlining the project proposal had taken place. Ethics approval for the project was obtained from South Tees Nursing and Paramedical Research Group.

Recruitment of participants involved several strategies.

- Distribution of flyers at South Cleveland Hospital, followed by invitations to targeted wards to attend a presentation within the hospital regarding the proposed study. Nursing staff recruited from those wards formed the basis for a “snowballing effect” to take place.
- Letters with return slips were sent to targeted wards for distribution to female staff members. The letters outlined the aims and methods of the study and the necessary criteria for participation. Women between the age range of 20-65 were invited to participate.

Excluded were those who were working night shift, pregnant, breast feeding, or who had a history of heart disease, diabetes or hypertension. This would minimise factors that may affect BP responses, such as diurnal variation of BP during waking and sleeping periods and the taking of anti-hypertensive medication.

## 1.2. Final sample

Three wards and two specialised units were targeted which resulted in the recruitment of 43 participants. Of those participants, 5 failed to complete a period of continuous ambulatory blood pressure with diary entries and a completed questionnaire and were therefore excluded from the study. The final sample size was 38, with a mean age of 36 years (SD 8.01). Age range was 23-52 years. Of those, 37 people completed the questionnaire, diary and a 20-24 hour period of ambulatory blood pressure monitoring. One participant completed the questionnaire and diary entries during a 14.5-hour period of monitoring, including 4.5 hours at home and 10 hours during work time.

Most of the study group worked full-time (Table 1). The sample was made up of 31 qualified nurses, 26 of whom were Staff Nurses, 5 Ward Sisters (2 of whom were Ward Managers), and 7 Health Care Assistants (HCA's). Although qualified nurses are involved in more complex tasks than HCA's their roles overlap at the basic nursing level. Participants were recruited from Wards 1 (Medical Assessment Unit), 3 (Haematology) and 4 (Medicine). Participating departments were the Coronary Care Unit and the Renal Dialysis Unit (Table 1).

	<b>N</b>
<b>Full-time/Part-time</b>	
<i>Full-time</i>	29
<i>Part-time</i>	9
<b>Status</b>	
<i>Sister/ Ward Manager</i>	5
<i>Staff Nurse</i>	26
<i>Health Care Assistant</i>	7
<b>Department</b>	
<i>Ward 1 (MAU)</i>	7
<i>Ward 3</i>	5
<i>Ward 4</i>	9
<i>Coronary Care Unit</i>	10
<i>Renal Dialysis Unit</i>	7

Table 1: Number and distribution of participants in the study.

Background information profiling the participants in the study is presented in the following table (Table 2). Due to the small numbers of postmenopausal participants involved, it was not possible to test the effects of menopause.

	<b>N</b>
<b>Smoking status</b>	
<i>Smoker</i>	9
<i>Non-smoker</i>	29
<b>Marital status</b>	
<i>Partner/ Married</i>	26
<i>Single</i>	6
<i>Widowed</i>	2
<i>Divorced</i>	4
<b>Children under 16 in home</b>	
<i>1 child</i>	2
<i>2 children</i>	9
<i>3 children</i>	8
<i>No children (under 16)</i>	19
<b>Menopausal status</b>	
<i>Premenopausal</i>	34
<i>Postmenopausal</i>	4
<b>Smoking/ Menopausal status</b>	
<i>Premenopausal smoker</i>	9
<i>Premenopausal non-smoker</i>	25
<i>Postmenopausal smoker</i>	0
<i>Postmenopausal non-smoker</i>	4

Table 2: Participant profile

### 1.3. Procedure

Return slips were collected from targeted wards or at the study presentation given in South Cleveland Hospital. Those interested in participating were then contacted by telephone or letter, or personally, within the workplace. Questionnaires and consent forms (Appendix 1) and a further written information sheet (Appendix 2) regarding the study were given or posted to each participant.

A period of 24-hour ambulatory blood pressure monitoring, including one working daytime shift was arranged at the convenience of each participant. Measurements of height, weight, waist and hips were taken prior to the monitoring sessions and questionnaires and consent forms were signed and collected at this time.

An explanatory instruction sheet regarding the wearing of the monitor and completion of the diary entries was left with each participant along with a contact telephone number (Appendix 3).

## **2. Measures**

### **2.1. Ambulatory blood pressure monitoring**

Ambulatory blood pressure monitoring (ABPM) took place over a continuous 24-hour period including a working day shift. Time periods for the recording of ambulatory blood pressure (ABP), heart rate (HR) and diary entries were half hourly from 9 a.m. to 10 p.m. (13 hours) and hourly from 10 p.m. until 9 a.m. (11 hours). This provided a maximum time period of 24 hours, during which measurements and activities in the home, workplace and during sleep were recorded.

### 2.1.1. Equipment used

The Spacelabs Medical Model 90207 ABP monitor (Spacelabs Medical, Inc. WA.), previously validated in other studies (Cates et al., 1990; Pickering et al., 1991), was used to record BP and HR measurements. It is a pocket-sized, lightweight, battery-powered unit designed for recording BP and HR over time periods of 24 or 48 hours or longer. Measurements were taken and recorded by the monitor and then data transferred to a PC.

Attaching a digital blood pressure meter model UA701 via a "T" tube connector checked the accuracy of the monitor. Three readings within 5 mm Hg were taken prior to monitoring the first participant and at weekly intervals throughout the data collection period. The monitor was worn several times by the researcher prior to data collection in order to anticipate any enquiries or problems likely to be experienced by participants and to verify the suitability of the equipment for the study. The ABP monitor was initialised prior to each session of monitoring. This established the time format, measurement interval, monitor tone, on/off periods and monitor display. The appropriate cuff size was selected for each participant, depending on limb circumference, either 24-32 cm (average adult cuff size) or 32-42 cm (large adult cuff size).

Participants were fitted with the monitor after an initial test reading and were verbally instructed regarding stop/start and on/off procedures. Written and verbal instructions were also given to each participant regarding the wearing of

the monitor. Practical points such as what to do during bathing and showering and how to minimise failed readings were addressed (Appendix 3).

## 2.2. Anthropometric measures

Weight and height were measured for the purposes of calculating body mass index (BMI). Height was measured using a standard tape measure. Participants removed their shoes and stood erect against a flat wall, with heels together and looking straight ahead (horizontally). Height was recorded to the nearest centimetre.

Weight was measured using a battery-operated digital display scale. Participants removed their shoes and any heavy objects about their person prior to being weighed (fully clothed). Body Mass Index (BMI), was calculated for all participants using the formula:  $M/H^2$  (where M = body weight in kilogrammes and H = height in metres). BMI is a widely used measure of obesity (Garrow and Webster, 1985; Heitman, 1990).

Waist and hip circumference were measured in centimetres using a standard tape measure. Waist measurements were taken from a point midway between the costal margin (lower rib) and the iliac crest. Hip measurements were taken over the largest portion of the buttocks, whilst keeping the legs together (Bost et al., 1995). Waist-hip ratio (WHR) is thought to be a more accurate predictor for health risks associated with body fat distribution in comparison to BMI (Lapidus et al., 1984). It has also been used as a measure in recent coronary heart disease research (Folsom et al., 1993) and was therefore considered

relevant in the anthropometric data collection. WHR was calculated as waist/hips.

Mid upper arm circumference was measured in some participants for the purposes of fitting an appropriately sized blood pressure cuff. Measurement was taken by tape measure at the halfway point between the acromion and olecranon processes, with the arm in a flexed position by the side (Garrow, 1993).

### **2.3. Questionnaire design**

#### **2.3.1. Measurement of job stress**

The background questionnaire included 25 items from Gray-Toft and Anderson's Nursing Stress Scale (1981a; 1981b). The original scale, developed in the USA, consisted of 34 items (Appendix 4) pertaining to previously identified stressful situations for nurses at work. The researcher chose to include items related to current work stress situations mentioned by nurses in the recruitment process (during discussion at the presentation). The decision to omit nine questions from the scale was taken to avoid a lengthy questionnaire and therefore present it as user-friendly. For each item, four response categories were given (as used by Gray-Toft and Anderson 1981a; 1981b), 'never', 'occasionally', 'frequently', and 'very frequently'. Use of this scale provided a previously validated tool (Gray-Toft and Anderson, 1981a; 1981b), specifically aimed at measuring the frequency with which nurses perceived certain situations as stressful. Items were categorised and

subsequently grouped into subscales (Factors I – VII) as in the original Scale. The number of items included in the study questionnaire is listed below. Full details of the Nursing Stress Scale (Gray-Toft and Anderson, 1981a; 1981b) and questions used in the questionnaire can be found in Appendix 4.

Factor I – Workload (6 items).

Factor II – Death and dying (6 items).

Factor III – Inadequate preparation (3 items).

Factor IV – Lack of staff support (3 items).

Factor V – Uncertainty concerning treatment (1 item).

Factor VI – Conflict with doctors (1 item).

Factor VII – Conflict with other nurses (5 items).

### **2.3.2. Cigarette smoking**

In addition to questions that would provide information regarding numbers of cigarettes smoked daily and years as a smoker, six questions relating to smoking behaviours were included in the background questionnaire. Items were chosen from the sedative and stimulant subscales of the Addiction Research Unit Smoking Motivation Questionnaire (West and Russell, 1985). This was a modified version of a previously constructed questionnaire by Russell et al. (1974) which identified and classified possible motives for smoking.

In this study, three questions from the stimulant and three from the sedative subscales were asked (Table 3). Questions were rated on a scale of 1-5 from, 'not at all', to, 'very much'.

	Subscale
I get a definite lift and feel more alert when smoking	Stimulant
Smoking helps to keep me going when I am tired	Stimulant
Smoking helps me think and concentrate	Stimulant
I smoke more when I am worried about something	Sedative
I smoke more when I am unhappy	Sedative
I light up a cigarette when I feel angry about something	Sedative

Table 3: Questions pertaining to smoking motivation

### 2.3.3. 24-hour diary

Diary entries during the 24-hour ambulatory blood pressure (ABP) monitoring period provided measurements of self-reported factors considered likely to affect ABP and HR. When participants felt a BP measurement being taken by the machine, they were asked to record their feelings and experiences over the half-hour or hour since the last ABP and HR measurement. The aim of the diary was to provide information to answer questions posed in the study hypotheses. Items chosen related to perceived busyness and choice, mood levels, posture, location, physical activity, smoking behaviour and intake of food and drink. These items were included in recent work examining ABP and stress (Kamarck et al., 1998) in order to assess factors related to cardiovascular changes.

Perceived busyness and choice of activity were chosen as an approximation of Karasek's (1979) concepts of demand and control, important factors in the study of workplace stress. In this study these factors and their effects were considered separately. Karasek's (1979) full model, measuring the interaction effect of job demand and control (job strain), was not tested in this thesis.

Previous studies using negative and positive mood items in diary form have shown the effects of mood on ABP and HR (James et al., 1986; Schwartz et al., 1994; Shapiro et al., 1997; Brown et al., 1998). Although such studies have examined the relationship between anger and ABP (James et al., 1986; Schwartz et al., 1994; Shapiro et al., 1997; Brown et al., 1998), frustration, not anger was the mood that nursing staff described (during the initial liaison meeting) as being significant at work. A combination of 2 positive (contented and cheerful) and 3 negative (frustrated, stressed and worried) moods (Mackay et al., 1978; Shapiro et al., 1997) were therefore selected and rated on a 7-point scale from not at all = 1, to very = 7. Stress was included because it was the mood central to this investigation.

For their research on recurring stress and ABP, Kamarck et al. (1998) constructed and validated a wider ranging diary, measuring self-reported social conflict, task strain and emotional activation (negative affect and arousal). Other factors investigated in their study were posture, activity, and choice of activity, intake of food, alcohol, caffeine and drugs. Kamarck et al.'s (1998) diary was designed to eliminate retrospective assessment by participants. Details had to be entered (using a laptop computer) into the diary within six

minutes of the BP recording or this was recorded as a missed assessment. Although this method ensured a high response rate from participants in Kamarck et al.'s (1998) research, it was thought unsuitable for working nursing staff in this study, because of the level of activity and priorities they face in their daily duties. The practicalities of carrying the diary were discussed in the initial meetings with senior nursing staff. It was important to make this tool as user-friendly as possible for the purpose of compliance and convenience.

The diary was therefore designed in pocket-sized booklet format, recording the selected items (Appendix 5). Entries were made half-hourly or hourly (whilst awake), corresponding with each ambulatory blood pressure measurement.

### **3. Statistics and Transformation of the Data**

#### **3.1. Home and work measurements**

A total of 764.5 monitoring hours were completed, comprising 435.5 hours at home and 329 hours in the workplace. Mean number of hours spent at home whilst awake were 5.66 and at work were 9.43. Table 4 shows the number of measurement periods during sleep, home and work. As previously mentioned, measurements were taken half-hourly during daytime and evening periods and hourly at night. Information from the ABP and HR readings, the diary, questionnaire and anthropometric measurements were compiled, forming the database for the analyses.

	N of measurements	Percentage of total n. of measurements
Sleep	254	18.19
Home (Awake)	340	24.35
Work	698	50.00
Other	104	7.45

Table 4: Sleep, home and work measurements

### 3.2. Transformation of the data

Data were reordered for the purpose of within-subject analysis, each assessment being treated as a case. Individual ABP, HR, perceived busyness and choice and mood measurements, recorded during the monitoring period, were converted to z-scores (standardised values) following the procedure used by James et al. (1986) and Brown et al. (1998). The variables were standardised separately for each individual. Adjusting the values to z-scores resulted in all recordings being rendered on the same scale, with the same mean (0) for each person. This removed the effects of between-individual variability in the analyses. By transforming the scores, all elevations in blood pressure and heart rate recordings associated with within-person changes in mood, smoking or activity, could be determined. All within-subject analyses were performed using the univariate format of the data. Unstandardised means are presented in the tables to allow easier interpretation. For other comparisons, between-subject analyses were applied using the multivariate data format (i.e. each person treated as a separate case). For the purposes of this study  $p < 0.05$  was accepted as significant in all analyses.

Although more complex methods of analysis of ABP and mood have been reported (Schwartz et al., 1994), this procedure, previously validated by James et al. (1986) and Brown et al. (1998) in their studies of blood pressure variability and mood, was accessible within the available statistical package (SPSS). Schwartz and Stone (1998) reviewed methods for analysing ecological momentary data and this provided a basis for the testing of interaction effects in the data.

#### **4. Analytical approach**

The first of the results chapters (Chapter Five) presents descriptive statistics relating to data collected in the background questionnaire. A report of the findings of the Nursing Stress Scale (Gray-Toft and Anderson, 1981a; 1981b), the motives for smoking subscales (West and Russell, 1985) and what was observed on the wards is given.

Chapters Six and Seven present the main results of the study. Chapter Six investigates factors that may affect ABP and HR and hypothesis one is tested here. Having examined statistics used in other papers, methods previously used by James et al. (1986), James et al. (1990) and Brown et al. (1998), (looking at within-subject questions using standardised scores) were applied using the univariate database. Analyses of variance were used to test the significance of the relationships between within-subject variables. Sleep values were excluded from the analyses at an early stage. This enabled more focused analyses exploring home and work differences.

In Chapter Seven, differences between smokers and non-smokers were explored and addressed using the multivariate database. Both analysis of variance and independent T-tests were used in the analyses. Finally, application of methods previously described by Schwartz and Stone (1998) concerning the analyses of ecological momentary data, were used to test for differences between the BP and HR responses to work, of smokers and non-smokers (as predicted in the second hypothesis).

## **CHAPTER FIVE – STRESS IN THE WORKPLACE**

The results of the study are presented in three chapters. This chapter presents descriptive statistics derived from the questionnaires and diaries, whilst the main results and analyses are presented in Chapters Six and Seven.

One of the central issues of this study was to examine stress in the workplace of nurses. Nurses have reported high levels of work stress in previous studies (Calhoun, 1980; Ivancevich and Matteson, 1980). Chapter Five presents descriptive statistics of reported stress in the background questionnaire and some of the observations made from situations reported whilst working on the wards.

### **1. Descriptive Statistics**

#### **1.1. The Nursing Stress Scale**

Included in the questionnaire was a work stress scale, identified as providing measurement of job stress pertaining to nursing staff. This scale was developed whilst investigating the causes and effects of stress in hospital based nurses and is designed to measure the frequency of stress experienced at work (Gray-Toft and Anderson, 1981a; 1981b). Questions relating to stressful work situations were identified and categorised into workload, death and dying, inadequate (emotional) preparation, lack of staff support, uncertainty concerning treatment, conflict with doctors and conflict with nurses. Nursing staff were asked to indicate how often they felt stressed by certain situations from these categories, i.e. never = 0, occasionally = 1, frequently = 2

and very frequently = 3. Scores for each category or subscale were totalled and means calculated, following the descriptive approach used by Gray-Toft and Anderson, 1981a; 1981b). Mean work stress in the study group is presented in Table 1.

Score: 0 - Never, 1 - Occasionally, 2- Frequently, 3 - Very Frequently.

Factors I – IV	Study group	
	N	Mean ± S.D
I - Workload	37	1.29 ± 0.40
II - Death & dying	35	1.34 ± 0.50
III -Inadequate preparation	37	0.95 ± 0.45
IV - Lack of staff support	37	0.64 ± 0.59
V - Uncertainty concerning treatment	37	0.81 ± 0.61
VI - Conflict with doctors	38	1.00 ± 0.51
VII - Conflict with other nurses	36	0.65 ± 0.39

Table 1: Mean work stress in nursing staff.

The study group as a whole was most often stressed by situations relating to death and dying, followed by workload and then conflict with doctors (Table 1). Situations pertaining to inadequate (emotional) preparation, lack of staff support, uncertainty concerning treatment and conflict with colleagues rated as causing less than occasional stress on the Nursing Stress Scale.

### 1.1.1. Reporting of work stress on individual wards and departments.

Staff from five wards or departments participated in the study. When scores were compared, the highest means (frequency of reporting) for workload were reported by Ward 1 (1.5). Coronary Care Unit (CCU) and Ward 3 reported highest mean stress (1.63 and 1.53) regarding matters of death and dying (Table 2). Mean scores regarding the subjects of workload and death and dying consistently rated as 'occasional' for all individual wards and departments. Minimal conflict with nurses was reported (mean <1) by all wards and departments. Conflict with doctors rated only slightly higher (occasionally), for three out of the five workplaces.

Score: 0 – Never, 1 - Occasionally, 2- Frequently, 3 – Very Frequently.

Factors I-VII	WARD 1	WARD 3	WARD 4	CCU	RDU
<b>Factor I</b> N	7	5	8	10	7
Mean ± S.D	1.5 ± 0.60	1.1 ± 0.09	1.3 ± 0.21	1.3 ± 0.42	1.1 ± 0.43
<b>Factor II</b> N	6	5	8	10	6
Mean ± S.D	1.1 ± 0.09	1.53 ± 0.72	1.3 ± 0.24	1.63 ± 0.6	1.0 ± 0.43
<b>Factor III</b> N	7	5	8	10	7
Mean ± S.D	0.8 ± 0.37	1.1 ± 0.72	1.1 ± 0.47	1.0 ± 0.43	0.8 ± 0.38
<b>Factor IV</b> N	7	5	8	10	7
Mean ± S.D	0.5 ± 0.47	1.13 ± 0.93	0.46 ± 0.43	0.87 ± 0.53	0.71 ± 0.49
<b>Factor V</b> N	7	5	8	10	7
Mean ± S.D	0.43 ± 0.53	1.2 ± 1.1	0.8 ± 0.46	1.0 ± 0.47	0.71 ± 0.49
<b>Factor VI</b> N	7	5	9	10	7
Mean ± S.D	0.86 ± 0.38	0.6 ± 0.55	1.1 ± 0.6	1.2 ± 0.42	1.0 ± 0.58
<b>Factor VII</b> N	7	4	8	10	7
Mean ± S.D	0.83 ± 0.34	0.4 ± 0.3	0.65 ± 0.3	0.78 ± 0.48	0.49 ± 0.4

Ward 1	Medical Assessment Unit	CCU	Coronary Care Unit
Ward 3	Haematology	RDU	Renal Dialysis Unit
Ward 4	Medicine		

Factor I	Workload	Factor V	Uncertainty re. treatment
II	Death and dying	VI	Conflict with doctors
III	Inadequate supervision	VII	Conflict with nurses
IV	Lack of staff support		

Table 2: Mean work stress reported on individual wards and departments.

### 1.1.2. Mean work stress reported in nursing staff, smokers and non-smokers

Smoking is sometimes considered to be a behavioural response to stress (Rose et al., 1983; Linn and Stein, 1985). Determination of perceived stress in smokers and non-smokers was therefore relevant to explore at descriptive level. Results are reported below (Table 3).

Score: 0 - Never, 1 - Occasionally, 2- Frequently, 3 - Very Frequently.

Factors I - IV	Smokers		Non-smokers	
	N	Mean $\pm$ S.D	N	Mean $\pm$ S.D
I - Workload	9	1.38 $\pm$ 0.44	28	1.26 $\pm$ 0.39
II - Death & dying	8	1.33 $\pm$ 0.33	27	1.35 $\pm$ 0.55
III - Inadequate preparation	8	1.00 $\pm$ 0.17	29	0.94 $\pm$ 0.51
IV - Lack of staff support	9	0.81 $\pm$ 0.50	28	0.59 $\pm$ 0.61
V - Uncertainty concerning treatment	9	1.11 $\pm$ 0.78	28	0.71 $\pm$ 0.53
VI - Conflict with doctors	9	1.00 $\pm$ 0.50	29	1.00 $\pm$ 0.53
VII - Conflict with other nurses	8	0.72 $\pm$ 0.44	28	0.63 $\pm$ 0.38

Table 3: Mean work stress in nursing staff: smokers and non-smokers.

Although smokers demonstrated a higher average (frequency) reported stress when compared with non-smokers, in five of the seven categories of stressful situations, the largest differences being in relation to uncertainty regarding treatment and lack of staff support (Table 3), there were no striking differences between the groups.

## 1.2. Smoking motivation

As outlined in the previous chapter (Chapter Four, Table 3), six questions from the sedative and stimulant subscales of the Addiction Research Unit Smoking Motivation Questionnaire (West and Russell, 1985), were included in the background questionnaire. Items selected were pertaining to smoking as a stimulus (3) and smoking as a sedative (3). The number of cigarettes smoked daily and for how many years were also reported. Descriptive statistics are tabulated below (Table 4).

Smokers	N	Mean $\pm$ S.D	Min	Max
Age	9	37.89 $\pm$ 5.60	31	47
Number of years smoking	9	17.56 $\pm$ 8.19	5	30
Number of cigarettes smoked per day	9	16.67 $\pm$ 6.12	10	30
Stimulant subscale	9	3.19 $\pm$ 1.32	2	5
Sedative subscale	9	3.96 $\pm$ 0.96	2	5

Table 4: Questions pertaining to smoking

Results from the subscales suggest that the sample of smokers tended to use cigarettes to relax (Table 4). This result is comparable to unpublished data from the Steptoe et al. (1996) study (Table 5), which also demonstrated that subjects, in this case male and female university students, smoked as a form of relaxation more than for stimulation.

Smokers	No.	Mean $\pm$ S.D	Min	Max
Age	31	21.68 $\pm$ 2.64	19	30
Stimulant subscale	31	2.44 $\pm$ 1.28	19	30
Sedative subscale	31	3.60 $\pm$ 1.07	19	30

Table 5: Unpublished data (Steptoe et al., 1996).

## 2. Information from the diaries: situations on the wards

The diaries not only provided information that was quantifiable (Chapters Six and Seven), but also included qualitative data, short descriptions of the activities of staff members during the ambulatory monitoring period. These reportings provided a snapshot of what was happening at that time on the wards. The significant episodes presented here, were rated as highly stressful or frustrating, and often very busy periods during the working day. Below is an account of some of the events recorded.

### 2.1. Events inducing feelings of stress

Both the wards and specialised departments were busy places where many hospital staff went about their various tasks. All participants undergoing anthropometric measurements and 24-hour ABP and HR monitoring verbally expressed feeling pressure of time. Even before work began there were stresses to face. Leaving an upset child at nursery was rated as particularly stressful for one nurse. For those staff who depended on driving to work, finding a parking space was usually the first significant stressful event prior to starting their shift. Staff arriving at work were experiencing stress before they

had walked onto the wards. Items listed below are nurses' reported experiences during their working day (Table 6).

Cardiac arrest – resulting in sudden death.
Cardiac arrest - resuscitation.
Other medical emergencies.
New machinery / plasma exchange.
Admissions.
Dealing with violent relatives – having to dial 999.
Attempting to persuade patient to complete treatment.
'Laying out' a body.
Nursing an extremely ill patient.
Finding staff to cover shortages.
Computer failure.
Tiredness.
Busyness.

Table 6: Nurses experiences during their working day.

Stressful events identified by nurses at work in Teeside fall into the five categories identified in the Nursing stress scale by Gray-Toft and Anderson (1981a; 1981b) and later by Dewe (1987).

### 3. Conclusion

Responses to the Nursing Stress Scale have demonstrated that on average most work situations were only occasionally stressful. The subject of death and dying and workload were the categories that demonstrated the highest mean scores when compared with the five other subscales.

## **CHAPTER SIX - FACTORS AFFECTING AMBULATORY BLOOD PRESSURE AND HEART RATE.**

Work was hypothesised as the main stressor in the lives of nurses. Thus the main focus of this chapter is the effects of work on ABP and HR. The possible contribution of physical factors such as caffeine intake, cigarette smoking and activity, to ABP and HR variation and any home or work differences in ABP and HR were assessed. Finally, the contribution of reported busyness, lack of control and mood, to home and work differences was assessed.

### **1. Sleep**

Firstly, factors influencing BP and HR readings such as sleeping and change of posture were determined in order to establish their effects. Results reported here initially examine cardiovascular changes during waking and sleeping periods. Analyses were conducted on standardised scores (z-scores) and F and P values reported where appropriate. For the purposes of interpretation, unstandardised means are presented in the tables.

To determine the effects of sleeping on mean ABP and HR at the within-person level, analysis of variance was conducted using standardised scores (Table 1). Comparisons in ABP and HR were made using measurements taken whilst reclining awake and during sleep at home. Z-scores were used in the analysis.

	<b>Systolic BP</b>	<b>Diastolic BP</b>	<b>Heart rate</b>
<b>Asleep</b> (Reclining)			
Mean $\pm$ St. Deviation	100.10 $\pm$ 10.80	58.31 $\pm$ 9.18	68.14 $\pm$ 10.89
N	237	237	237
<b>Awake</b> (Reclining)			
Mean $\pm$ St. Deviation	106.18 $\pm$ 11.12	62.27 $\pm$ 9.38	76.94 $\pm$ 16.10
N	55	55	55
<b>F</b>	21.98	9.49	28.56
<b>P</b>	<0.001	<0.005	<0.001

Table 1: Ambulatory BP and HR whilst awake and asleep.

Systolic and diastolic ABP and HR readings were found to be significantly higher whilst awake than during sleep (Table1). At this stage, sleep was excluded from the analyses and all subsequent analyses utilised only 'waking data'. Also excluded at this point in the study were ABP and HR readings that took place outside of work or home situations. This allowed for more focused analyses of home and work ABP and HR. These data will be analysed separately in the future.

## 2. The effects of posture

Ambulatory blood pressure studies have found that observed effects of posture were larger than those observed in laboratory settings for both systolic and diastolic BP and HR (Santucci et al., 1988). It has been suggested that everyday changes in position are often associated with changes in the level of arousal, therefore accounting for observed greater effects (Schwartz et al., 1994). Blood pressure is generally raised whilst standing in comparison with

sitting or reclining BP, reclining being the lowest. Posture, therefore, was expected to have a significant influence on blood pressure (Gellman et al., 1990; James, 1991). Mean blood pressure and heart rate (z-scores) were calculated for each position at the within subject level (Table 2).

<b>Posture</b>	<b>Systolic BP</b>	<b>Diastolic BP</b>	<b>Heart rate</b>
<b>Reclining (awake)</b>			
Mean $\pm$ Std. Deviation	105.90 $\pm$ 11.14	61.84 $\pm$ 9.33	76.61 $\pm$ 15.91
N	55	55	55
<b>Sitting</b>			
Mean $\pm$ Std. Deviation	118.89 $\pm$ 13.71	74.71 $\pm$ 10.43	81.24 $\pm$ 13.77
N	374	374	373
<b>Standing</b>			
Mean $\pm$ Std. Deviation	119.41 $\pm$ 12.35	76.98 $\pm$ 9.92	87.86 $\pm$ 15.26
N	573	573	572
<b>F</b>	30.33	76.23	73.03
<b>P</b>	<0.001	<0.001	<0.001

Table 2: The effects of posture on ABP and HR.

As expected, there was an increase in mean ABP and HR from the reclining to sitting position and a further increase in mean ABP and HR when standing. Analysis of variance showed a significant association between posture and mean ABP and HR (Table 2). The effects of posture (reclining, sitting or standing) on ABP and HR was then controlled for in subsequent analyses by including it as an independent variable (unless otherwise stated).

### **3. Factors that may affect blood pressure and heart rate.**

As well as posture, there are other relevant factors in this study that may have an effect on blood pressure and heart rate. Activities during the day such as drinking tea, coffee or other caffeinated drinks, smoking a cigarette and different levels of physical activity were recorded in the diaries.

The following question relating to these factors was initially addressed.

- Is there evidence to show the effects of caffeine, smoking or physical activity on ABP and HR measurements?

The next stage in the analyses will seek to address the above question, by examining each factor in relation to ambulatory BP and HR.

At first, standardised scores (z-scores) of mean blood pressure and heart rate associated with reported intake of caffeine and cigarette smoking and levels of physical activity were calculated. Table 3 shows mean levels of ABP and HR during periods when these activities were reported. Posture was controlled for in the analysis by including it as an independent variable. Results are presented in Tables 3 and 4.

		<b>Systolic BP</b>	<b>Diastolic BP</b>	<b>Heart rate</b>	
<b>Caffeine</b>	<b>Yes</b>	Mean ± S.D	119.19 ± 12.21	75.64 ± 10.55	85.84 ± 14.92
	<b>No</b>		117.92 ± 14.60	75.18 ± 10.67	84.49 ± 15.29
	<b>Yes</b>	N	236	236	236
	<b>No</b>		763	763	761
<b>Cigarette</b>	<b>Yes</b>	Mean ± S.D	120.00 ± 11.02	77.80 ± 9.79	82.76 ± 11.54
	<b>No</b>		118.00 ± 13.29	75.13 ± 10.67	84.90 ± 15.41
	<b>Yes</b>	N	63	63	63
	<b>No</b>		939	939	937
<b>Active</b>	<b>Yes</b>	Mean ± S.D	119.81 ± 12.79	76.80 ± 9.64	87.03 ± 15.00
	<b>No</b>		117.11 ± 13.44	73.78 ± 11.38	82.51 ± 15.11
	<b>Yes</b>	N	504	504	503
	<b>No</b>		494	494	493

Table 3: Effects of caffeine, cigarette smoking and level of physical activity on ABP and HR.

	F	P
<b>Systolic BP z-score (overall model)</b>	12.67	<0.001
Caffeine	0.72	0.39
Cigarettes	1.00	0.31
Physical activity	0.69	0.40
Posture	24.09	<0.001
<b>Diastolic BP z-score (overall model)</b>	30.88	<0.001
Caffeine	0.13	0.71
Cigarettes	0.45	0.50
Physical activity	0.15	0.69
Posture	62.43	<0.001
<b>Heart rate z-score (overall model)</b>	30.60	<0.001
Caffeine	0.64	0.42
Cigarettes	0.27	0.60
Physical activity	5.44	<0.05
Posture	43.06	<0.001

Table 4: Effects of caffeine, cigarette smoking and level of physical activity on ABP and HR: F and P values.

Table 4 shows that, at the within-subject level, an increased level of activity significantly increased HR, an effect not demonstrated by smoking a cigarette or intake of caffeine. The small number of observations during episodes of cigarette smoking reflects the small number of smokers in the sample and the limited period during which they were able to smoke (smoking was only permitted in designated areas during breaks). In answer to the question posed regarding this analysis, ABP in nursing staff was not significantly raised in response to having a caffeinated drink, smoking a cigarette or by an increase in level of activity. Nevertheless, since others (Clark et al., 1987; James and

Pickering, 1991; Gropelli et al., 1992; Narkiewicz et al., 1995; Lane et al., 1998) using larger data sets, have shown that all these factors influence BP and HR, they were retained in later analyses.

#### 4. Blood Pressure in the Home and Work Environment

The following section examined the issue of whether being at work raised nurses' blood pressure. Factors that may affect ABP and HR were examined in relation to location (home and work). The first step in the examination was to evaluate the relationship between systolic and diastolic ABP, HR and location. Standardised scores were utilised and posture excluded in this analysis. Descriptive statistics are presented below (Table 5).

	<b>Systolic BP</b>	<b>Diastolic BP</b>	<b>Heart Rate</b>
<b>Home</b>			
Mean $\pm$ S.D	114.97 $\pm$ 14.07	70.48 $\pm$ 11.70	78.80 $\pm$ 14.39
N	329	329	329
<b>Work</b>			
Mean $\pm$ S.D	120.16 $\pm$ 12.32	77.59 $\pm$ 9.25	87.62 $\pm$ 14.75
N	676	676	674
F	35.67	109.29	80.26
P	<0.001	<0.001	<0.001

Table 5: Mean ABP and HR at home and work.

Nursing staff demonstrated significantly higher ABP and HR at work when compared with home (Table 5).

Posture had been shown in previous analyses (Table 2) to have a significant influence on ABP and HR. The number of reported recordings of posture at home and work are tabulated below (Table 6).

<b>Posture</b>	<b>Home</b>	<b>Work</b>
	N	N
	Percent	Percent
<b>Reclining</b>	54 16.0%	1 0.1%
<b>Sitting</b>	188 55.8%	197 28.2%
<b>Standing</b>	95 28.2%	500 71.6%

Table 6: Posture at home and work

From this table (Table 6), it can be seen that nurses at work spent considerably more time standing than they did sitting. At home, they spent more than half of their time sitting and some time reclining. There was one recording of reclining at work, during a break period.

The next step was to ascertain whether the home and work differences in ABP and HR could be explained by posture. By including posture as a factor in the model, it would be possible to determine whether home and work differences in ABP and HR remained significant. Standardised scores were used in the analysis and F and P values reported.

	F	P
<b>Systolic BP</b> z-score (overall model)	25.55	<0.001
Posture	15.14	<0.001
Home/work	15.27	<0.001
<b>DiastolicBP</b> z-score (overall model)	65.88	<0.001
Posture	36.10	<0.001
Home/work	39.35	<0.001
<b>Heart rate</b> z-score (overall model)	58.79	<0.001
Posture	35.23	<0.001
Home/work	26.56	<0.001

Table 7: Mean BP and HR at home and work: F and P values.

Nursing staff were found to have significantly higher mean work systolic and diastolic ABP and HR when compared with those measurements taken at home (Table 7). Controlling for posture had reduced, but not removed the home and work difference (as can be seen by comparing the F values in Tables 5 and 7). In answer to the first of the study hypotheses (Chapter 3), being at work did raise nurses' ABP and HR.

#### 4.1. Factors that may further affect home and work ABP and HR

Factors that may affect ABP and HR differences between home and work were then addressed. It had previously been shown that smoking a cigarette and drinking caffeine did not significantly raise ABP or HR (Tables 3 and 4). Reported numbers of these events during the monitoring period, including that of physical activity are tabulated below (Table 8).

	Home	Work
	N	N
	Percent	Percent
<b>Taking a caffeine drink</b>	79 23.6%	170 24.4%
<b><i>No caffeine drink</i></b>	256 76.4%	526 75.6%
<b>Smoking a cigarette</b>	48 14.2%	21 3.0%
<b><i>Not smoking</i></b>	291 85.8%	677 97.0%
<b>Physically active</b>	62 18.5%	460 66.2%
<b><i>Not active</i></b>	273 81.5%	235 33.8%

Table 8: Number of reported episodes at home and work when drinking caffeine, smoking a cigarette and physical activity.

Descriptive statistics presented here, show that caffeine consumption is similar between work and home and not surprisingly, nursing staff were considerably more active at work than at home. As might be expected, more smoking was reported at home than at work (where smoking was restricted). These observations give rise to further questions in the investigation of work BP and HR.

- Is the difference between home and work BP and HR affected when caffeine, smoking and physical activity is controlled in the analysis?

The next stage was to examine home and work differences in ABP and HR whilst controlling for these variables and level of activity. Z-scores were used in the analysis and exact 'p' values are presented (Table 9).

	<b>F</b>	<b>P</b>
<b>Systolic BP</b> z-score (overall model)	13.70	<0.001
Caffeine	0.26	0.61
Cigarettes	3.69	0.06
Physical activity	0.20	0.65
Posture	13.61	<0.001
Home/work	17.79	<0.001
<b>Diastolic BP</b> z-score (overall model)	34.86	<0.001
Caffeine	0.04	0.84
Cigarettes	4.84	0.03
Physical activity	2.74	0.10
Posture	35.26	<0.001
Homework	47.51	<0.001
<b>Heart rate</b> z-score (overall model)	29.69	<0.001
Caffeine	0.17	0.68
Cigarettes	0.27	0.60
Physical activity	0.73	0.39
Posture	27.82	<0.001
Homework	21.94	<0.001

Table 9: Home and work BP and HR controlling for caffeine, smoking a cigarette and physical activity.

In this analysis smoking was significantly associated with raised diastolic BP. Prior to home and work being introduced into the model, smoking had no significant influence on ABP. It appears that controlling for the home/work

difference allowed the effect of smoking to be revealed. In answer to the study question, controlling for caffeine, smoking and physical activity did not however, remove the effect of situation. This implies that ABP and HR measurements at home and work are significantly different whether or not those factors were controlled for.

#### 4.2. Perceptions of work: busyness, own choice and mood.

In this study it has been hypothesised that work is the main stressor in the lives of nurses. Examination of their perception of busyness, choice and mood at work was necessary to establish whether there were significant differences between home and work. In other words, were work and home differences in ABP and HR caused by busyness, choice or mood? Initially, the effect of busyness and choice on ABP and HR was addressed. Measurement of perceived busy periods and choice of activity were recorded in the diary. The 7-point scale ranged from, 'not at all my choice' / 'not at all busy' (1), to, 'very much my choice' / 'very busy' (7). Table 10 presents one-way Pearson correlations of the factors busyness, own choice and mood with ABP and HR (z-scores were used in the analysis).

	Z-score systolic	Z-score diastolic	Z-Score heart rate
<b>Z-Busy</b>	0.129 ***	0.202 ***	0.282 ***
<b>Z-Own choice</b>	-0.093 **	-0.178 ***	-0.166 ***
<b>Z-Stress</b>	0.086 **	0.13 ***	0.225 ***
<b>Z-Frustration</b>	0.021	0.036	0.133 ***
<b>Z-Contented</b>	-0.103 **	-0.146 ***	-0.167 ***
<b>Z-Cheerful</b>	-0.069 *	-0.086 **	-0.098 **
<b>Z-Worried</b>	0.07 *	0.131 ***	0.123 ***

Significance level:  $p < 0.001 = ***$        $p < 0.01 = **$        $p < 0.05 = *$

Table 10: Pearson correlations between standardised variables measuring ABP and HR, mood, own choice and busyness.

Pearson correlations demonstrated a relationship between increasing busyness and rise in ABP and HR at the within-subject level. Own choice (or lack of choice) was inversely correlated with ABP and HR, as were positive moods that demonstrated a decrease in ABP and HR the more positive the mood reported. Stress and worry showed an increase in ABP and HR the stronger the intensity of reporting, although frustration was only significantly correlated with HR (Table 10).

The next step was to conduct analysis of variance at the within-subject level to investigate these associations between ABP and HR. Z-scores were used and posture, caffeine, smoking a cigarette and physical activity were controlled in

the analysis. Results are presented in the table and exact 'p' values reported (Table 11).

#### 4.3 Busyness and choice

	<b>F</b>	<b>P</b>
<b>Systolic BP</b> z-score (overall model)	8.75	<0.001
Busyness	1.78	0.18
Own choice	0.89	0.35
Caffeine	0.53	0.47
Cigarettes	0.65	0.42
Physical activity	0.00	0.98
Posture	18.74	<0.001
<b>Diastolic BP</b> z-score (overall model)	23.47	<0.001
Busyness	4.24	0.04
Own choice	6.30	0.01
Caffeine	0.00	0.98
Cigarettes	0.94	0.33
Physical activity	0.50	0.48
Posture	45.84	<0.001
<b>Heart rate</b> z-score (overall model)	22.26	<0.001
Busyness	7.80	0.005
Own choice	0.48	0.49
Caffeine	0.26	0.61
Cigarettes	0.08	0.77
Physical activity	1.38	0.24
Posture	26.65	<0.001

Table 11: The effect of busyness and own choice on ABP and HR

After controlling for the other variables, being busy had a significant positive effect on the diastolic ABP and HR of nursing staff. Systolic ABP was not significantly affected by busyness. Lack of own choice of activity was negatively associated with diastolic BP. Systolic ABP and HR was not affected by choice (Table 11).

The next stage was to explore home and work differences in busyness and own choice. Means for reported busyness and own choice at home and work are shown in Table 12.

	<b>Home</b>	<b>Work</b>	<b>F</b>	<b>P</b>
<b>Busy periods</b>				
Mean $\pm$ S.D	1.87 $\pm$ 1.47	3.42 $\pm$ 1.88	172.375	<0.001
N	330	694		
<b>Own choice</b>				
Mean $\pm$ S.D	5.96 $\pm$ 1.90	3.85 $\pm$ 2.07	245.812	<0.001
N	332	691		

Table 12: Perceived busy periods and own choice at home and work.

Not surprisingly, participants reported being busier and having less choice at work than at home and this difference was highly significant (Table 12). Whether the home and work difference in ABP and HR was explained by these differences is determined by a further analysis, controlling for posture, caffeine, smoking a cigarette and level of activity. Busyness and own choice were

included as covariates and z-scores used in the analysis. Exact 'p' values are presented (Table 13).

	<b>F</b>	<b>P</b>
<b>Systolic BP</b> z-score (overall model)	9.14	<0.001
Busyness	0.61	0.44
Own choice	0.00	0.97
Caffeine	0.22	0.64
Cigarettes	2.15	0.14
Physical activity	0.55	0.46
Posture	12.74	<0.001
Home/work	11.27	0.001
<b>Diastolic BP</b> z-score (overall model)	24.48	<0.001
Busyness	1.48	0.22
Own choice	0.94	0.33
Caffeine	0.14	0.71
Cigarettes	4.05	0.04
Physical activity	3.52	0.06
Posture	31.80	<0.001
Home/work	27.08	<0.001
<b>Heart rate</b> z-score (overall model)	21.09	<0.001
Busyness	4.95	0.03
Own choice	0.08	0.78
Caffeine	0.06	0.81
Cigarettes	0.15	0.70
Physical activity	0.12	0.70
Posture	27.34	<0.001
Home/work	11.21	0.001

Table 13: The effects of busyness and choice on home/ work ABP and HR.

Home/work levels of ABP and HR remained significantly different in all of these analyses, suggesting that, statistically speaking, reported busyness and choice did not explain home/work differences in ABP and HR. However, these independent variables were highly correlated with each other, making interpretation difficult. It seems reasonable to suggest that including busyness, in particular, accounted for some of the home/work differences observed, particularly since the F values for home/work are smaller in these models than in the models reported in Table 9.

#### **4.4 Mood**

Determination of how mood influenced ABP and HR was the next stage in the analyses. The relationship between ABP, HR and stress in nursing staff was the focus of the study hypotheses, therefore stress was the factor selected to add to the model (Table 14).

	F	P
<b>Systolic BP</b> z-score (overall model)	7.67	<0.001
Busyness	1.16	0.28
Own choice	0.75	0.39
Caffeine	0.56	0.46
Cigarettes	0.69	0.41
Physical activity	0.00	0.96
Posture	18.74	<0.001
Stress	0.20	0.65
<b>Diastolic BP</b> z-score (overall model)	20.54	<0.001
Busyness	3.02	0.08
Own choice	5.83	0.02
Caffeine	0.00	0.96
Cigarettes	1.00	0.32
Physical activity	0.44	0.51
Posture	45.83	<0.001
Stress	0.23	0.63
<b>Heart rate</b> z-score (overall model)	21.11	<0.001
Busyness	1.88	0.17
Own choice	0.04	0.84
Caffeine	0.44	0.51
Cigarettes	0.01	0.93
Physical activity	2.11	0.15
Posture	26.71	<0.001
Stress	11.35	0.001

Table 14: The effect of stress on ABP and HR.

Analysis of variance demonstrated that once the effects of the other variables were controlled, reported stress had a significant effect on HR but not on systolic or diastolic BP.

#### 4.5 Work and stress

The next analysis ascertained whether differences in HR at home and work, could be explained by stress. Measurement of perceived mood levels were recorded on a 7-point scale from, not at all (1), to, very (7) in the diary. Initially analysis of variance was conducted to determine reported mood (the dependent variable) in home and work locations. Table 15 presents means for moods reported at home and work.

<b>MOOD</b>	<b>HOME</b>	<b>WORK</b>	<b>F</b>	<b>P</b>
<b>Frustrated</b> Mean $\pm$ S.D N	1.57 $\pm$ 1.11 333	2.40 $\pm$ 1.56 694	83.79	<0.001
<b>Contented</b> Mean $\pm$ S.D N	5.29 $\pm$ 1.87 330	4.40 $\pm$ 1.70 694	107.81	<0.001
<b>Stressed</b> Mean $\pm$ S.D N	1.81 $\pm$ 1.27 333	2.62 $\pm$ 1.61 694	58.11	<0.001
<b>Cheerful</b> Mean $\pm$ S.D N	5.02 $\pm$ 1.53 333	4.64 $\pm$ 1.60 690	10.91	<0.005
<b>Worried</b> Mean $\pm$ S.D N	1.58 $\pm$ 1.10 333	2.03 $\pm$ 1.35 694	30.97	<0.001

Table 15: Mean moods reported at home and work.

Reported mood levels (frustration, contentment, stress, cheerfulness and worried) were found to be significantly different between home and work situations (Table 15). More positive moods were reported at home (cheerful and contented), whilst, in comparison negative moods (frustration, stress and worry) were reported more at work.

So far the analyses has presented a picture of nursing staff who report being more busy at work than at home and have less influence over their choice of activity at work than at home. More stress, frustration and worry were experienced at work than in the home and one-way correlations showed that these negative moods were associated with higher ABP and HR. However, we have seen that stress was not significantly associated with ABP, although it did significantly predict HR, when included in a complete model. As a final step in the analyses, stress was added to the models predicting ABP and HR, to see whether it might account for the home/work effect. Posture is included as an independent variable and caffeine, smoking a cigarette and level of activity are covariates in the analysis. Z-scores are used and exact 'p' values reported (Table 16).

	<b>F</b>	<b>P</b>
<b>Systolic BP</b> z-score (overall model)	8.14	<0.001
Busyness	0.34	0.56
Own choice	0.01	0.92
Caffeine	0.24	0.63
Cigarettes	2.21	0.14
Physical activity	0.50	0.48
Posture	12.75	<0.001
Stress	0.16	0.69
Home/work	11.22	0.001
<b>Diastolic BP</b> z-score (overall model)	21.76	<0.001
Busyness	0.98	0.32
Own choice	0.82	0.37
Caffeine	0.13	0.72
Cigarettes	4.13	0.42
Physical activity	0.50	0.48
Posture	31.80	<0.001
Stress	0.16	0.69
Home/work	26.99	<0.001
<b>Heart rate</b> z-score (overall model)	20.18	<0.001
Busyness	0.77	0.38
Own choice	0.53	0.47
Caffeine	0.16	0.69
Cigarettes	0.33	0.57
Physical activity	0.45	0.50
Posture	21.39	<0.001
Stress	11.13	0.001
Home/work	11.00	0.001

Table 16: The effect of stress on home and work BP and HR.

Home and work ABP and HR remained significantly different, despite the effects of stress on HR (Table 16).

## **5. Conclusion**

Having controlled for all related factors that may influence ABP and HR, it has now been established that work ABP and HR were significantly higher when compared with home as hypothesised (Chapter 3). Although busyness (Table 11) and stress (Table 14) have been shown to influence HR, (Tables 13 and 16) and busyness and own choice were also associated with diastolic ABP (Table 11), home and work differences were not fully accounted for by these things.

## CHAPTER SEVEN – THE EFFECT OF SMOKING ON THE RELATIONSHIP BETWEEN STRESS AND BLOOD PRESSURE.

The previous chapter examined factors that may affect the blood pressure and heart rate of nurses during a working day. At the within-subject level, work ABP and HR were found to be significantly higher than those recorded at home, and reported stress was shown to have an effect on HR. One of the issues of interest in this study was the effects of the likely suppression of oestrogen in smokers. It was therefore necessary to exclude postmenopausal women prior to the analyses presented in this chapter. The main focus of this chapter, is the testing of the second hypothesis (outlined in Chapter 3), that is, do smokers show greater BP reactivity and less HR reactivity than non-smokers? Initially, however, other relevant differences between smokers and non-smokers were explored.

- Did smokers demonstrate significant differences in their average blood pressure and heart rate when compared with non-smokers?
- Did smokers demonstrate higher levels of stress than non-smokers?

### **1. Differences between smokers and non-smokers at the between-subject level**

Initial analysis was at the between-subject level, using the multivariate database and compared mean ABP and HR of the two groups. Age, body mass index (BMI) and waist-hip ratio (WHR) were controlled in the analyses.

Mean ABP and HR of smokers and non-smokers are reported below (Tables 1 and 2).

	<b>Mean Syst BP ± S.D</b>	<b>Mean Dias BP ± S.D</b>	<b>Mean HR ± S.D</b>
	<b>N</b>	<b>N</b>	<b>N</b>
<b>Smoker</b>	115.00 ± 9.62 9	73.44 ± 7.30 9	81.44 ± 10.74 9
<b>Non-smoker</b>	114.44 ± 9.79 25	70.36 ± 5.74 25	81.20 ± 9.44 25

Table 1: Mean ABP and HR in smokers and non-smokers.

	<b>F</b>	<b>P</b>
<b>Mean Systolic BP</b> (overall model)	3.63	<0.05
Non-smoker/smoker	0.55	0.46
Age	1.52	0.23
BMI	6.27	<0.05
WHR	0.37	0.55
<b>Mean Diastolic BP</b> (overall model)	1.80	0.16
Non-smoker/smoker	3.01	0.09
Age	1.23	0.28
BMI	0.42	0.52
WHR	1.63	0.21
<b>Mean Heart rate</b> (overall model)	0.97	0.44
Non-smoker/smoker	0.63	0.80
Age	0.19	0.67
BMI	3.41	0.08
WHR	0.69	0.41

Table 2: Mean ABP and HR in smokers and non-smokers: F and P values.

In answer to the first question posed at the beginning of this chapter, no significant differences were found in the ABP or HR of smokers and non-smokers (at the between-subject level) in the study.

Of interest in this study is whether smokers in general (in this sample) have higher levels of stress than non-smokers. To address this point, further analysis at the between-subject level, determined average perceived levels of stress over the period of data collection, reported by both smokers and non-smokers. An independent t-test was conducted to compare the means between the groups using the multivariate format data (Table 3).

	<b>Mean ± S.D</b>
	<b>Number</b>
<b>Smoker</b>	2.56 ± 0.94 9
<b>Non-smoker</b>	2.33 ± 0.94 25
<b>F</b>	0.001
<b>Sig. (2-tailed)</b>	0.97

Table 3: Mean stress in smokers and non-smokers.

No differences were found between the means of the groups at the between-subject level. Smokers had the same ABP and HR (Tables 1 and 2) as non-smokers and the same ratings of stress (Table 3).

## **2. Home and work differences in smokers and non-smokers**

Having established that smokers and non-smokers were not significantly different groups at the between-individual level, further examination at the within-subject level using the univariate format data, was necessary to determine the relationship, if any, between smoking, stress and blood pressure reactivity. The main question asked was:

- Do smokers demonstrate bigger BP and smaller HR responses to work stress than non-smokers?

In addition, analyses were performed to check the answer to the following question, which may affect the interpretation of the answer to the first.

- Do smokers have a different experience of work compared to home than non-smokers?

By using methods described by Schwartz and Stone (1998) in their paper discussing the analysis of ecological momentary data (see Chapter 3), it was possible to test the interaction effect of a between-subject factor (smoking status), with a within-subject factor (home/work), using the univariate data set.

### **2.1. Interaction effects between smoking status and home and work**

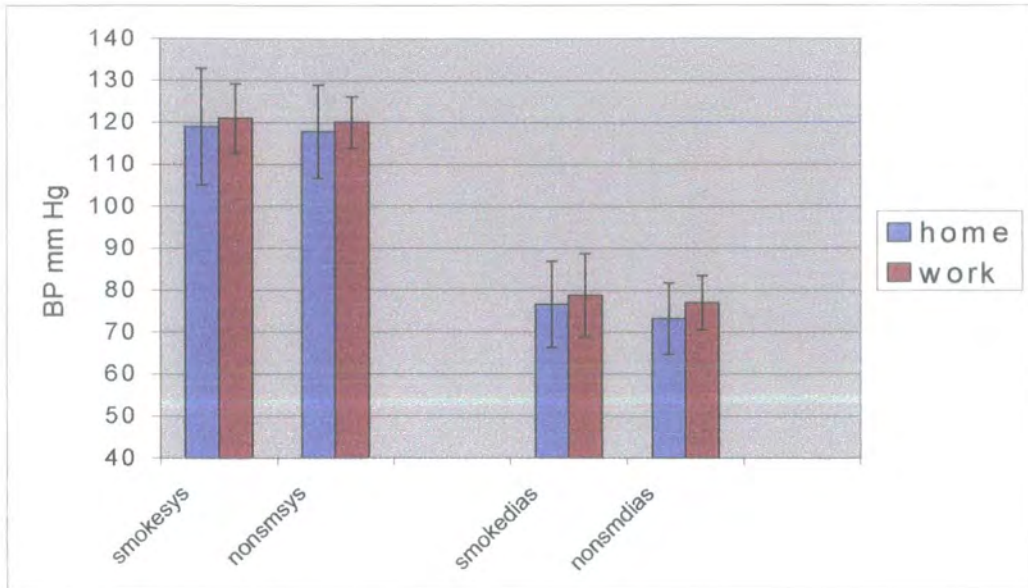
Initial examination looked at the interaction effect of smoking status and a within-subject factor, location (home and work); with ABP and HR as the

outcome variable. Posture, caffeine, smoking a cigarette and level of activity were controlled in the model and standardised values for ABP and HR were used (Table 4).

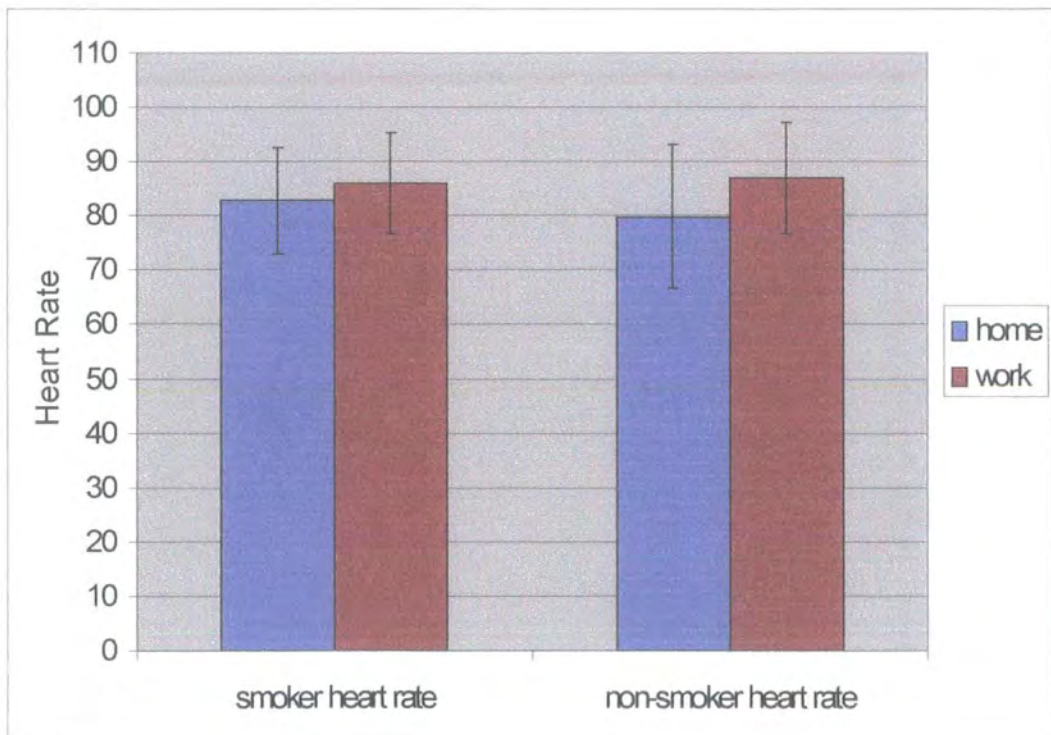
	<b>F</b>	<b>P</b>
<b>Z-score Systolic BP</b> (overall model)	10.45	<0.001
Non-smoker/smoker * homework	0.40	0.67
Homework	15.74	<0.001
Caffeine	0.01	0.95
Cigarettes	4.45	<0.05
Physical activity	1.07	0.30
Posture	13.95	<0.001
<b>Z-score Diastolic BP</b> (overall model)	29.15	<0.001
Non-smoker/smoker * homework	2.24	0.11
Homework	36.11	<0.001
Caffeine	0.52	0.47
Cigarettes	6.30	<0.05
Physical activity	4.35	<0.05
Posture	38.62	<0.001
<b>Z-score Heart rate</b> (overall model)	21.63	<0.001
Non-smoker/smoker * homework	2.79	0.06
Homework	11.76	<0.05
Caffeine	0.25	0.62
Cigarettes	0.10	0.75
Physical activity	0.80	0.37
Posture	22.49	<0.001

Table 4: Interaction effect of smoking status and location (home and work).

The interaction effect between smokers and non-smokers at home and work was not significant (Graphs 1 and 2). The effect for HR approached significance however, and the interaction was of the form predicted.



Graph 1: Mean home/work ambulatory BP in smokers and non-smokers



Graph 2: Mean home/work ambulatory HR in smokers and non-smokers

The next stage in the analyses was to examine the home and work experience of stress of smokers and non-smokers to see if they were the same. This model tested the interaction effect of a between-subject factor, smoking status, and a within-subject factor, location (home and work). Stress (standardised) was included as the outcome variable in the analysis (Table 5).

	<b>F</b>	<b>P</b>
<b>Z-score Stress</b> (overall model)	18.19	<0.001
Non-smoker/smoker * homework	0.08	0.92
Homework	45.31	<0.001

Table 5: Interaction effect of smoking status and location (home and work).

As before the interaction effect between smokers and non-smokers at home and work was not significant, demonstrating that smokers have the same experience of change in stress from home to work as do non-smokers (Table 5).

### 3. Conclusion

This chapter has shown that nursing staff who smoked did not show more blood pressure or less HR response to work when compared with non-smoking staff. The second study hypothesis (Chapter 3) is therefore not supported.

## CHAPTER EIGHT – DISCUSSION

The aim of this study was to determine the effect of stress on ABP and HR in smoking and non-smoking nurses during their working day. Nurses' experiences of home and work were found to be clearly different, at both psychological and physiological levels. Negative moods were felt more at work than home. Occurrences of positive moods were reported more often at home than at work. Work ambulatory blood pressure (ABP) and heart rate (HR) were significantly higher than that at home. Non-smokers showed no differences in their experiences, when compared with smokers. A discussion of these results follows. Initially, factors affecting ABP and HR are discussed, followed by an examination of the findings for the two groups, smokers and non-smokers.

### **1. Effects of sleep and posture on ABP and HR**

#### **1.1. Sleep**

Systolic and diastolic ABP and HR were significantly higher whilst awake than during sleep, at the within-subject level. This finding was expected and supports the results of previous studies measuring blood pressure at home (Pickering et al., 1982; James et al., 1986; Clark et al., 1987; Gellman et al., 1990).

## 1.2. Posture

Posture was significantly associated with ABP and HR at the within-subject level with both ABP and HR, rising from the reclining to sitting position and further increasing when standing. This had been previously noted in earlier studies using ABP monitoring (James et al., 1986; Santucci et al., 1988; Gellman et al., 1990; Schwartz et al., 1994; Brown et al., 1998) and was therefore not a surprising finding. In the present study nursing staff spent considerably more time at work standing than sitting. At home this situation was reversed (Chapter 6, Table 6). Everyday changes in posture showed a similar pattern in Brown et al.'s (1998) study of nurses in Hawaii. Schwartz et al. (1994) suggested that the significant effects of posture in their work and other non-laboratory based studies examining mood and position, as determinants of ABP and HR, are often associated with changes in arousal levels. Clearly it is important to control for the effects of posture, however there are other issues attached to posture as Schwartz et al. (1994) have pointed out.

## **2. Effects of smoking, caffeine and physical activity on ABP and HR**

### **2.1. Cigarette smoking**

In the present study, documented entries of the number of cigarettes smoked revealed that smoking was predominantly a behaviour that took place at home in leisure time. After controlling for the important effect of location, analyses

showed that diastolic ABP was affected by smoking a cigarette and the significance of the effect for systolic ABP was borderline. HR showed no significant change in the analysis. Previous analyses that did not control for location as a factor showed no significant effect of smoking.

Laboratory work in earlier studies has shown that BP rises immediately in response to smoking a cigarette (Groppelli et al., 1992). The authors also found that daytime ABP was higher for smokers when compared with non-smokers (Gropelli et al., 1992), smokers who drank coffee at the same time demonstrated higher again daytime ABP (Narkiewicz et al., 1995). Morgan et al.'s (2001) recent study, looking at the effects of occupation, stress and location on ABP and HR in American female nurses found that HR was significantly increased by smoking.

## **2.2. Caffeine**

Ingestion of caffeine demonstrated no significant effect on the ABP and HR of nursing staff at the within-subject level in the present study. In contrast, caffeine has previously been found to elevate systolic and diastolic BP in normotensive coffee drinkers (particularly near the time of ingestion) and overnight heart rate. The authors also found that caffeine ingestion was also associated with increased negative affect (Green and Suls, 1996), suggesting that increased caffeine consumption may be a behaviour that occurs as a result of negative affect.

Further evidence to support caffeine's effect on ambulatory measurements can be drawn from an examination of a small group of people in the work environment who had a significant and consistent rise in ABP during the monitoring period on days where caffeinated coffee was drunk. There was no effect on HR (Jeong and Dimsdale, 1990). More recent work, comparing dose-related data during ABP monitoring over two working days, found significantly higher ABP and HR readings related to the dose of caffeine (Lane et al., 1998). It is possible that no similar effect was observed in the present study because of the difficulties in accurately quantifying caffeine intake from coffee, tea and caffeinated carbonated drinks.

Combining caffeine intake with smoking was found to result in significant increases in systolic BP in mildly hypertensive subjects (Narkiewicz et al., 1995), however this interaction was not tested for in the present analyses because these behaviours did not take place at the same time whilst on the wards.

### **2.3. Physical activity**

At the within-subject level, an increased level of activity significantly increased HR but surprisingly, not ABP. Other studies with larger data sets have shown that increased levels of physical activity are responsible for increases in ABP and HR (Clark et al., 1987; James and Pickering, 1991). Earlier work has shown that rigorous exercise can substantially increase systolic BP, although it has to be noted that participants were hypertensive (Watson et al., 1979). It is

possible that in the present study, small numbers of participants, the crude (yes/no) measure of activity used, and error in measuring physical activity may be responsible for this finding. It is of note that nursing staff were unlikely to engage in prolonged rigorous exercise whilst at work despite the physical nature of certain tasks e.g. bed-making. Most reporting of rigorous exercise took place out of the home and work situations e.g. in the gym, and were excluded from the analyses in the present study in order to examine home and work data only.

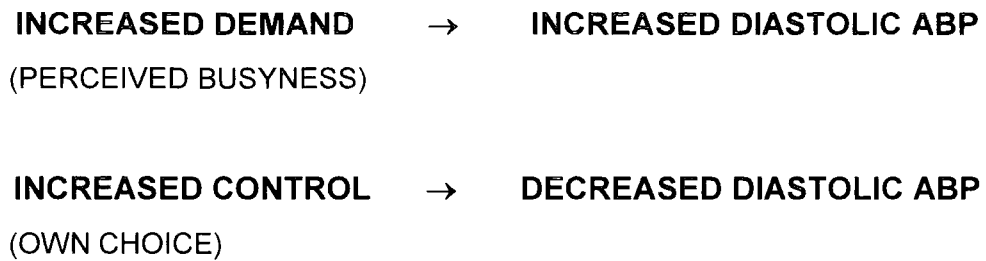
### **3. Effects of work on ABP and HR**

#### **3. 1. Busyness and Own Choice**

Being busy was associated with an increase in HR as would be expected. Schwartz et al.'s (1994) study of 246 normotensive men and women over a 24-hour period found a mild increase in HR during periods where participants felt rushed. Diastolic ABP was also significantly affected by perceived busyness in the present study, although this was not the case for systolic ABP. Similarly, lack of choice in the workplace was associated with a significant rise in diastolic ABP which was not the case for systolic ABP. Heart rate was not affected by choice.

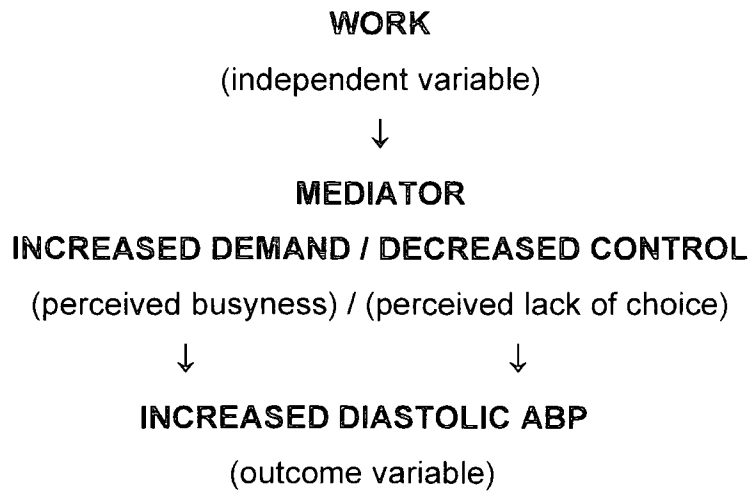
As discussed in the review of the literature (Chapter 2), two dimensions of work have been linked with ill health in general and BP in particular in previous studies, demand (psychological stressors related to workload) and decision

latitude (perceived level of control in the workplace). Karasek and Theorell (1990) suggested that increased demand led to an increase in BP, whilst increased control lowered BP. In the present study there was evidence to show that diastolic ABP changed in nurses in this manner (Figure 1).



**Figure 1.** Effects of increased demand and control on diastolic ABP.

Although busyness and own choice became non-significant after adding location to the model, they did account for some of the variance in the analyses in this study (Chapter 6, Tables 11 and 13). This suggests that demand and control in the workplace may partially mediate the relationship between work and diastolic ABP. Baron and Kenny (1986), sought to clarify the relationship between factors (or variables) and mediating factors. Application of this model to the present study demonstrates the associations between work demand (perceived busyness) and control (perceived lack of choice) in the workplace, and ABP and HR (Figure 2).



**Figure 2.** Effects of increased demand and decreased control on ABP

Some studies have found that demand is a stronger predictor of BP than control. Theorell et al. (1988) found that increased job demand significantly increased systolic BP in male and female participants, but this was not the case for job control. Similarly job demands were associated with daytime systolic ABP and HR but not job control in a study of female American nurses (Goldstein et al., 1999). Other studies examining job demand and control in female nurses have found no associations with BP (Brown and James, 2000; Reise et al., 2000).

#### **4. Effect of work on mood**

Levels of frustration, contentment, stress cheerfulness and worry were significantly different depending whether nursing staff were at home or in the workplace. As expected more positive moods were experienced at home, whilst negative moods were mostly reported at work. Similarly, a study of ABP

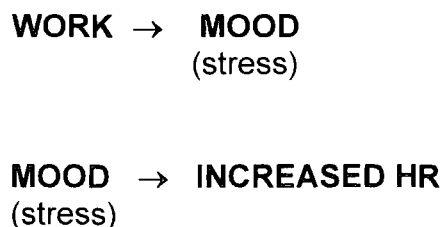
in Hawaiian nurses also reported more negative feelings at work than at home and being happier at home than at work (Brown et al., 1998).

Work was associated with negative moods but perceived stress was the focus of the second study hypothesis and therefore the effects of stress were investigated in more detail than all other moods.

Responses to the Nursing Stress Scale (Chapter 5) found that stress related to death and dying rated the highest mean scores in comparison to other categories. This finding was similar to that of Gray-Toft and Anderson (1981a; 1981b), who found three categories with the most frequently reported stress, namely; death and dying, workload and feeling inadequately prepared to meet the emotional demands of patients and relatives.

#### 4.1. Mood, blood pressure and heart rate

The relationship between work, mood, BP and HR is central to this study. Work had an impact on mood (stress) and stress was predictive of HR (Figure 3).



**Figure 3:** The effect of work stress on heart rate

Perceived stress significantly increased HR although not ABP at the within-subject level, once other variables were controlled. A study examining mood

and ambulatory HR concluded that stress was the mood most predictive of changes in HR (Johnston and Anastasiades, 1990). Interestingly, in another study looking at cardiovascular changes affected by moods, Schwartz et al. (1994) found that few participants (190 men and 56 women) reported negative moods and that stress was related to only a mild rise in HR. However this reporting may have been due to questionnaire format, since (as the authors point out), in their assessment of mood, the strength of emotion was not rated (Schwartz et al., 1994). Shapiro et al.'s (1997) study of daily mood states and ABP consisted of a more evenly distributed sample of 197 males and females, and found that reported mood (inclusive of stress) was not associated with HR.

In a laboratory based study measuring cardiovascular reactivity to behavioural stressors, it is of interest that premenopausal women were noted to increase their heart rate more than men when stressed, perhaps as a result of oestrogen levels (Girdler and Light, 1994). The authors found that stressed men reacted differently and as a result of peripheral vascular resistance, increased their BP. Although women in the present study demonstrated a rise in HR in response to stress, an exploration of gender differences in perceived stress and cardiovascular reactivity could not be undertaken.

Although not significant in this study, perceived stress in women in the workplace has been associated with increases in ABP (James et al., 1989; James and Bovbjerg, 2001).

## **5. Home and work differences in ABP and HR**

The most significant and consistent finding in this study was the difference in home and work ABP and HR. Work ABP and HR were significantly higher than home recordings at the within-subject level, despite having controlled for all relevant factors (posture, smoking, caffeine, physical activity, busyness, and lack of choice and mood). In keeping with these findings, other researchers have shown ABP to be higher at work than at home (Pickering et al., 1982; James et al., 1986; Clark et al., 1987; Gellman et al., 1990; Schwartz et al., 1994). Studies of female nurses have also demonstrated higher work than home ABP (Brown et al., 1998), although Brown and James (2000) found this association with diastolic ABP only. Although ABP monitoring was used in these studies, not all participants were normotensive (e.g. Pickering et al., 1982; James et al., 1986; Clark et al., 1987 and Gellman et al., 1990) and since hypertensives may have altered BP responses to stress, it is important to establish similar responses in normotensives, as in the present study.

Smoking a cigarette did produce an increase in diastolic ABP, but not as large as the increase caused as a result of location, in this study. Home activities may have been responsible for increases in ABP in smokers, but work ABP remained higher. Of importance is that location has been shown to be associated with ABP and HR in this study, independent of other significant factors.

Carel et al.'s (1998) recent review of psychosocial effects on ABP also concluded that there was a body of evidence to support the findings that work ABP was characteristically higher than that at home. Being at home or work showed differences in the ABP and HR of nurses, which were not fully explained in this study. A larger sample may identify causal factors.

## **6. Differences in smokers and non-smokers**

### **6.1. Smoking and stress**

Analyses at the between and within-subject levels, revealed that smokers and non-smokers had the same experience of stress. A much larger sample of 448 hospital nurses measuring job-related stress on a 26-item scale did report higher stress levels in smokers than non-smokers (Tagliacozzo and Vaughn, 1982). In a large-scale study of over 8,000 Swedish subjects, Karasek et al., (1987) found that stress at work had a stronger association with smoking for women than it did for men. In some circumstances, smoking has been shown to increase as perceived stress increases (Linn and Stein, 1985) and it is thought to be a means of dealing with low mood (Beiner, 1987). However, nurses who smoked in this study tended to do so at home and their motives were generally ones of relaxation.



## 6.2. Smoking and ABP and HR

This study has shown that nurses have higher ABP and HR at work in comparison with home, which leads to the next issue which is, did smokers show different ABP and HR responses when compared with non-smokers? Although having a cigarette increased diastolic BP in the present study, no differences were noted when comparing the average ABP and HR of smokers with that of non-smokers, nor was there strong evidence that the BP and HR responses to work of smokers were different to those of non-smokers.

In laboratory work measuring cardiovascular changes in men and women in response to stress tests, women who were cigarette smokers were shown to have raised peripheral resistance and thus BP, and lower cardiac output and heart rate when compared with women who did not smoke (Girdler et al., 1997). This response is thought more in common with male cardiovascular changes than female and may be related to oestrogen suppression in smokers (Girdler et al., 1997). The present study sought to test whether the same effect could be observed in everyday life and found no significant effect. There was however, a tendency for the HR response to work of smokers, to be smaller than that of non-smokers, a finding consistent with the idea that oestrogen levels are suppressed in smokers. However there were few smokers in the study and this limited the power of the analyses.

## **7. Study limitations**

The small number of smokers recruited may have acted as a restricting factor in this study. A larger sample size would have provided not only increased power to the analyses, but also a greater number of postmenopausal women for comparative analyses with premenopausal women. Lack of funding for this research meant that it was not possible to measure oestrogen.

A further consideration was that completion of diary entries at the point of, or as near to the ambulatory BP and HR reading as possible, took a high level of commitment in the working day of a nurse. It has to be considered that due to impracticalities on the wards, there was not always immediately time to make a recording of mood. For example, whilst dealing with medical emergencies such as three events of myocardial infarction, diary entries were likely to be last priority. It is unlikely however, that studies of workers in critical areas such as the present study, could produce more accurate mood recordings.

Finally, it is acknowledged that certain factors such as physical activity and caffeine that may influence BP and HR, were subject to crude and self-reported measurements in comparison with the physiological measurements obtained from the recording of ABP and HR.

## **8. Conclusion**

This study confirms that blood pressure in women does respond to the work environment as it has done in previous studies on men. Experiences of home and work were clearly very different. Furthermore, perceived stress was predictive of heart rate. Only comparisons with men may ascertain gender differences in blood pressure and heart rate responses to work stress.

Future studies measuring oestrogen and cardiovascular responses to stress may help determine oestrogen's role in modifying cardiovascular risk, and whether the effects of oestrogen suppression on cardiovascular responses affect smokers' cardiovascular disease risk.

# APPENDICES

# Appendix 1

## Nurse Stress Study

### Questionnaire

**Please answer all the following questions. If you have any queries please ask the researcher for advice. Telephone:**

**The information from your questionnaire will be treated confidentially.**

**Please bring this questionnaire with you on the arranged day of blood pressure monitoring. Thank you.**

Name:

Contact Address:

Telephone No:

Date:

Please answer the following questions about your work. **Indicate how often you have felt stressed by the following situations** by marking one box per question.

		Never	Occasionally	Frequently	Very frequently
1	Performing procedures that patients experience as painful				
2	Not enough time to complete all of my nursing tasks				
3	The death of a patient				
4	Not enough time to provide enough emotional support to a patient				
5	Breakdown of a computer				
6	Not enough staff to adequately staff the unit				
7	Too many non-nursing tasks required, such as clerical work				
8	Feeling helpless in the case of a patient who fails to improve				
9	Listening or talking to a patient about his / her approaching death				
10	Unpredictable staffing and scheduling				
11	Difficulty in working with a particular nurse (or nurses) on the unit				
12	Uncertainty regarding the operation and functioning of specialised equipment				
13	Feeling inadequately prepared to help with the emotional needs of a patient's family				
14	Conflict with a supervisor				
15	Being asked a question by a patient for which I do not have a satisfactory answer				

		Never	Occasionally	Frequently	Very frequently
16	Fear of making a mistake in treating a patient				
17	Feeling inadequately prepared to help with the emotional needs of a patient				
18	Lack of an opportunity to talk openly with other unit personnel about problems on the unit				
19	Difficulty in working with a particular nurse (or nurses) outside the unit				
20	The death of a patient with whom you developed a close relationship				
21	Lack of an opportunity to share experiences and feelings with other personnel on the unit				
22	Floating to other units that are short-staffed				
23	Watching a patient suffer				
24	Criticism by a supervisor				
25	Lack of an opportunity to express to other personnel on the unit my negative feelings toward patients				





**Finally, could you please answer the following questions regarding you and your job.**

How old are you?      What is your job title?

What are your qualifications? (educational & professional)

Are you? (please circle the appropriate answer).

Single   Living with a partner   Married      Widowed      Divorced      Separated

How many children under the age of 16 live with you in your care?

How important is your income for your household? (please circle the appropriate number).

Not essential   1      2      3      4      5      Absolutely essential

Do you work full-time or part-time?

How many years have you worked in the service?

**Thank you very much for taking the time to fill in this questionnaire!**

## Consent Form

**I have read the information sheet and agree to take part in the Nurse Stress Study.**

Name (please print) \_\_\_\_\_

Signature \_\_\_\_\_

Investigator's Signature \_\_\_\_\_

Date \_\_\_\_\_

Copy to be kept by participant.

**Please keep this page and the Participant Information Sheet**

## Consent Form

**I have read the information sheet and agree to take part in the Nurse Stress Study.**

Name (please print) \_\_\_\_\_

Signature \_\_\_\_\_

Investigator's Signature \_\_\_\_\_

Date \_\_\_\_\_

Copy to be kept by researcher.

**Please detach this and return it with your questionnaire.**

## Appendix 2

### Participant Information Sheet

The aim of this study is to examine the relationship between stress, blood pressure, and cigarette smoking in female nurses during their working day. The focus of the study is on physiological changes and their relevance to cardiovascular risk. Nurses experience considerable stress in their work and we are interested in investigating how that stress affects you.

As a participant you will be asked to take part in an initial (brief) interview involving the filling out of a questionnaire, the taking of your waist, hip and height measurements, and given a further explanation of the study by the researcher. You will then be asked to take part in a 24-hour period of monitoring your blood pressure using a small portable monitor. During this period a small questionnaire or diary will be provided to record several things that may be happening in your day, such as, level of activity, busy periods and your mood level.

The information you give is completely confidential and will be made anonymous for the purpose of the study. We will let you know your blood pressure readings for the 24-hour monitoring period and inform you if your blood pressure readings appear to be above the normal range. If this is the case, we will suggest you consult your General Practitioner.

Participation in this study is entirely voluntary and you can withdraw at any time. If you have any questions regarding this study at any time, please contact the researcher on: \_\_\_\_\_.

## Appendix 3

### Nurse Stress Study: Instructions

**\*\* Please try not to change your daily routine. This study is designed to see what happens during your normal daily routine \*\***

#### **Wearing the Ambulatory Blood Pressure Monitor:**

Your blood pressure will be monitored for a 24-hour period including a normal working day. A demonstration will be given regarding how to wear it and how to switch it on and off. During the day, measurements will take place every half hour. During the night they will take place every hour. Please keep as still as possible whilst the cuff inflates and deflates. Switch the machine on 15 minutes prior to the start of the 24-hour period (the researcher is likely to be there for instruction). Once the first reading has taken you will be familiar with what to expect and you will be able to predict the time of the next reading. This makes having a shower or bath possible - just remove the cuff and monitor for a period within the 30 minutes. Please give yourself enough time to replace the cuff prior to the next reading! If you need to remove the cuff for any reason **please ensure you replace it with the arrow over your brachial artery.** You will know it is successfully measuring by the display. An **EC** code usually means it has failed to measure BP. In the case of not being able to read your BP the monitor will retry once, 5 minutes later. Movement and excessive noise are usually the reasons for this. Fill out your diary as near as possible to the BP reading - it should just take a minute.

(An LLL code is a low battery warning. It is highly unlikely this will occur, however the researcher will instruct you regarding replacement of batteries).

**Care of the monitor: Because this is an expensive piece of equipment, please make every effort to keep it dry!**

Should you have any queries, please do not hesitate to call. Support is on hand throughout the monitoring period. Once again, thank you very much for agreeing to participate.

**Telephone:-**

## Appendix 4

### **The Nursing Stress Scale**

Gray-Toft and Anderson (1981a)

*(Items in brackets were excluded.)*

#### **Factor I: Work load**

Breakdown of the computer

Unpredictable staffing and scheduling

Too many non-nursing tasks required, such as clerical work

Not enough time to provide emotional support to a patient

Not enough time to complete all my nursing tasks

Not enough staff to adequately cover the unit

#### **Factor II: Death and dying**

Performing procedures that patients experience as painful

Feeling helpless in the case of a patient who fails to improve

Listening or talking to a patient about his/her approaching death

The death of a patient

The death of a patient with whom you developed a close relationship

*(Physician not being present when a patient dies)*

Watching a patient suffer

#### **Factor III: Inadequate preparation**

Feeling inadequately prepared to help with the emotional needs of a patient's family

Being asked a question by a patient for which I do not have a satisfactory answer

Feeling inadequately prepared to help with the emotional needs of a patient

#### **Factor IV: Lack of staff support**

Lack of an opportunity to talk openly with other unit personnel about problems on the unit

Lack of an opportunity to share experiences and feelings with other personnel on the unit

Lack of an opportunity to express to other personnel on the unit my negative feelings towards patients

#### **Factor V: Uncertainty concerning treatment**

*(Inadequate information from a physician regarding the medical condition of a patient)*

*(A physician ordering what appears to be inappropriate treatment for a patient)*

*(A physician not being present in a medical emergency)*

*(Not knowing what a patient or a patient's family ought to be told about the patient's medical condition and its treatment)*

Uncertainty regarding the operation and functioning of specialized equipment

#### **Factor VI: Conflict with physicians**

*(Criticism by a physician)*

Conflict with a physician

*(Fear of making a mistake treating a patient)*

*(Making a decision concerning a patient when the physician is unavailable)*

#### **Factor VII: Conflict with other nurses**

Conflict with a supervisor

Floating to other units that are short-staffed

Difficulty in working with a particular nurse (or nurses) outside the unit

Criticism by a supervisor

Difficulty in working with a particular nurse (or nurses) on the unit

For the purposes of this study the word 'Physician' was replaced by 'Doctor' in each of the sub-scales used.



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