

**Absenteeism and Musculoskeletal Pain:
An interactive network of variables**

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requirements for the degree of Master of Science (Medicine))**

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ABSTRACT

A cross-sectional analytic study was conducted of 98 supermarket cashiers in eight supermarkets throughout the Western Cape. This study was requested by the Occupational Health Practitioner at a prominent supermarket chain in South Africa who was concerned about the high level of absenteeism among the cashiers. There was speculation that the checkout designs, which were imported, may not 'fit' the user population and may be contributing to a high incidence of upper extremity musculoskeletal pain which was reported most often as the reason for sick leave. The study aimed to investigate whether musculoskeletal pain was significantly associated with absenteeism or whether other factors, such as stress (emotional and musculoskeletal); workstation usability problems; number of children; age, health, previous musculoskeletal injury, checkout design, job satisfaction, stressful relationships and perception of supervision significantly influenced the relationship. The measurement methods used were questionnaire/interview and tape measurements of anthropometric dimensions and checkout design. High levels of musculoskeletal pain were found in each supermarket and a high proportion of absent days was reported to be due to musculoskeletal pain, although no clear association was found with absenteeism. The anthropometric variable standing hip height as well as the duration of pain experienced were shown to be significantly associated with reported musculoskeletal pain levels. This study was not able to show a clear relationship between musculoskeletal pain and absenteeism. Findings showed emotional stress as well as the anthropometric variables stature and reach to be clearly related to absenteeism, whilst standing hip height, usability problems and the length of time the pain was felt were found to be related to reports of musculoskeletal pain. Further study to develop a model with good predictive ability to reduce ergonomic stressors, using simple surveillance methods, is needed.

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“Every industrial society generates - and must then settle – a conflict between its functions of production and of the protection of the producer, between the needs of the economy and the biological and psychological requirements of the workers and between the demands of industrial growth and the quality of individual and social life.”

J. Carpentier and P. Camazian in Night Work, Geneva, 1977, International Labour Organisation

1. INTRODUCTION

Background to Study

In 1997 the Occupational Health Practitioner at the head office of a large national chain of supermarkets became concerned about the increased incidence of reported shoulder and back musculoskeletal pain in the supermarket cashier department. This high incidence of back and shoulder musculoskeletal pain as well as high absenteeism amongst cashiers prompted the Occupational Health Practitioner to investigate the possible network of variables between musculoskeletal pain and absenteeism. The Biomedical Engineering Department and the Community Health Department at the University of Cape Town (UCT) were consulted and it was decided to commence a study as a Masters Thesis. The research project commenced on 1 February 1998.

The existing literature on musculoskeletal pain and absenteeism in checkout workers was system accessed using the computerized database MEDLINE for the period July 1997 to August 1999. Relevant articles were also accessed via reference lists from these articles.

A review of existing literature revealed that studies done on absenteeism have generally examined bivariate correlations between a set of variables and subsequent absenteeism (Steers et al., 1978; Burton et al., 1997; Symonds et al., 1996). Previous studies have found a direct correlation between increased levels of absenteeism from work and being a mother with children (Pheasant, 1991); a short duration of employment (Hagberg et al., 1995 and Burgmeier et al., 1988); increased levels of musculoskeletal and emotional

1995 and Burgmeier et al., 1988); increased levels of musculoskeletal and emotional stress (Riihimaki, 1991; Frymoyer et al., 1983; Matrunola, 1996); young age (Mets, 1994; Burgmeier et al., 1988); increased back pain (Burgmeier et al., 1988); bad health (Hagberg et al., 1995); previous musculoskeletal injury (Hagberg et al., 1995); lack of 'fit' between cashier and checkout design (Mackay et al., 1998; Burgmeier et al., 1988; Linton, 1990); previous musculoskeletal injury (Hagberg et al., 1995); decreased job satisfaction (Steers et al., 1978) and stressful relationships in the work environment (Mets, 1994; European Foundation, 1995). However, not much in the way of theory building has been done.

Furthermore, some of the current work on absenteeism suggest that employees are generally free to choose whether or not to come to work. As noted by Herman (1973) and Mets (1994), this is often not the case. Herman noted that in a variety of studies, important situational constraints (e.g. poor health and family responsibilities, wages and the risk of dismissal) have been found to influence the employee attitude-behaviour relationship. Symonds et al. (1996) found that attitudes towards pain and beliefs about pain were influential in the recovery process and return to work. As Steers et al. (1978) puts it, a comprehensive model of attendance must include not only job attitudes and other influences on attendance motivation but also situational constraints.

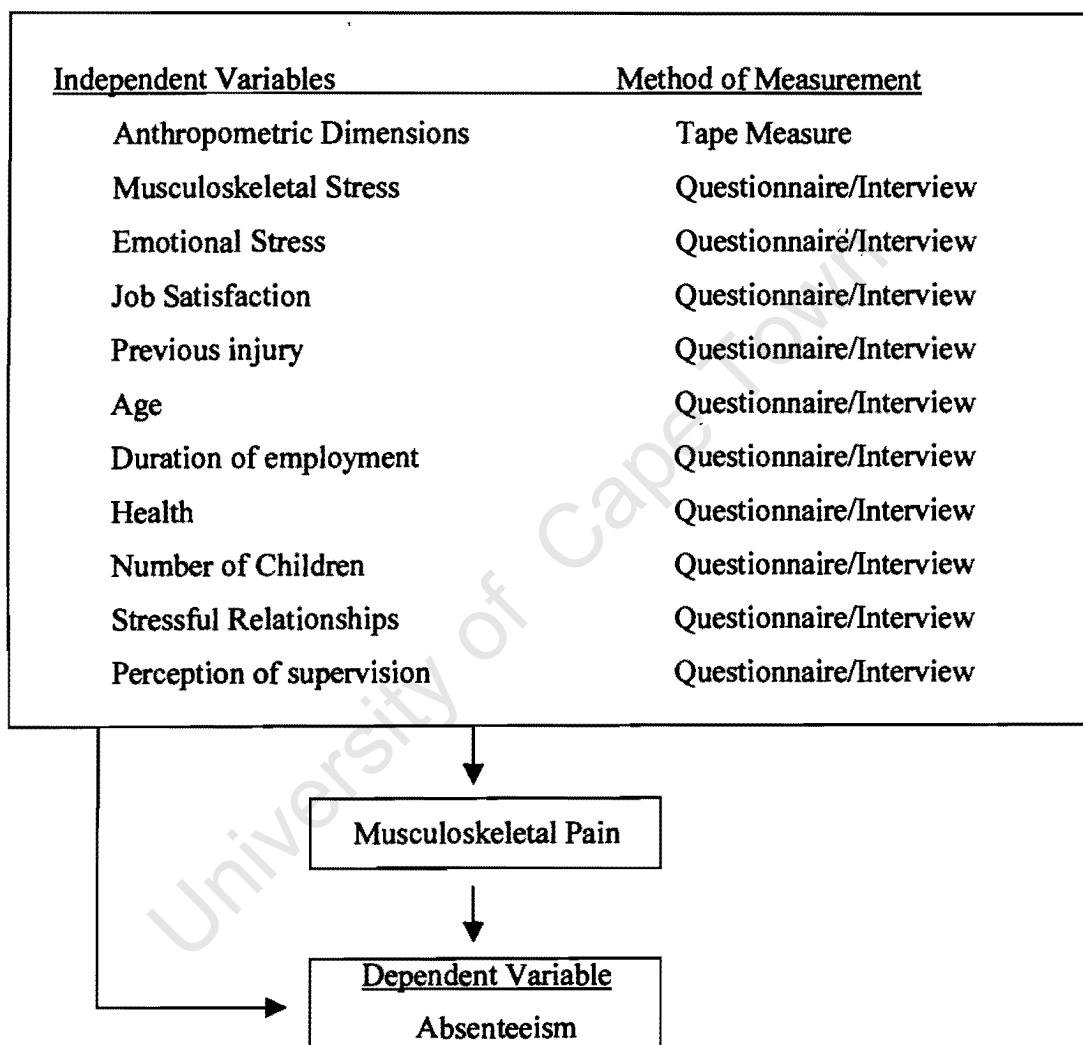
Objectives

The aim of the study was to consider the variables which effect absenteeism, and the relationship between these and the employees rate of absence. Uncovering an associative network of variables would contribute to the understanding of reasons for absenteeism. The intention was that a understanding of these variables would assist in reducing the prevalence of musculoskeletal pain amongst checkout workers, thereby both directly and indirectly improving the quality of customer service

The questions that need to be answered are 1) how do the selected variables form a network that as its outcome absenteeism or musculoskeletal pain, and 2) what is the

strength of association and relationship of these variables to each other and to the dependent variables absenteeism and musculoskeletal pain.

Figure 1 Model of variables considered in this study



2. LITERATURE REVIEW

2.1. Absenteeism

Absenteeism has been defined as “non attendance when expected to work, for any reason at all, medical or other” (Mets, 1994).

Some absence due to sickness/injury is regarded as ‘normal’, in that it is “in line” with the prevailing morbidity of the population, labour market situation and various other factors, and has therefore become acceptable to employers.

Absenteeism is seen to be ‘abnormal’ when occurring in excess. Mets (1994) refers to ‘abnormal’ absenteeism as workdays lost or frequent absent days that are unauthorised and short term. Mets (1994) suggests that if the duration is less than four days, there is a need for absence rather than a real necessity for days off, even though a physician may have certified the absence. Excessive absenteeism has been viewed as a symptom which indicates something wrong with a persons work environment or social relationships (European Foundation, 1995; Mets, 1994).

To understand absenteeism one has to look at the meaning of work to the individual. Sickness and injury are viewed as the “perception or experience of illness or injury by the patient” (Mets, 1994). Not all sickness or injury leads to absenteeism, but rather the worker who decides whether or not to work (Mets, 1994; Hogerzeil, 1968). The point at which absence occurs, according to Hogerzeil (1968) depends on a person’s threshold for reporting sickness or injury. This threshold has been seen to be markedly influenced by a worker’s personal motivation as well as personal, social, cultural, economic and ergonomic environment (Volvo Report, 1975; European Foundation, 1995).

The Gross Absenteeism Rate (GAR), defined by Mets (1994), is the total days of absence expressed as a percentage of potential working days, though it is a crude measurement of absenteeism, it is widely used. A GAR of 5% may be taken as a sign that the ‘situation

needs to be investigated' and a GAR of 10% may be taken as 'serious'. A high GAR only serves as an indication that something is wrong, whilst its components, Sickness Absence Rate (SAR) and Unauthorised Absence Rate (UAR) have been used to help locate where the causes lie. SAR is the total number of certified sickness absence days, expressed as percentage of potential working days, whilst UAR is the total number of unauthorised days expressed as a percentage of potential working days. If the SAR is high and a high proportion has been shown to be due to sickness spells lasting longer than four days, it may be assumed that there is a high degree of morbidity in the labour force, indicating a medical rather than a managerial problem. If on the other hand an excessive number of days lost due to unauthorised absence may indicate that the 'absence culture' of the organisation is too lenient or that the workers need frequent withdrawal from the stressful work situation.

Within the working environment there are many variables that can affect the levels of absenteeism. Some of these variables may be internal, that is, they originate within the working environment, whilst others are external and as such are not able to be regulated by management.

2.1.1. Internal Variables

2.1.1.1. Personal Variables

Absence behaviour has been seen as essentially personal in nature in that a choice is involved which is motivated by personal factors. Studies show that older age appears to be associated with lower absenteeism (Mets, 1994; Burgmeier et al., 1988; Matrunola et al., 1996). Older age usually implies a better-integrated personality and more responsibility, especially if dependents are involved. Combined with social responsibilities, having dependents has also been shown to be associated with lower absenteeism (Pheasant, 1991; Mets, 1994).

Greater length of service has also been shown to be associated with lower absenteeism

(Hagberg et al., 1995; Burgmeier et al., 1988; Mets, 1994). The higher stability of older workers may be regulated by having to provide for dependants and having fewer options for work, as he or she gets older.

Higher status within a work organisation has also been related to less absenteeism and has been shown to be associated with higher satisfaction and personal motivation in the work situation (Mets, 1994; Magora, 1973b).

Researchers (Mets, 1994; Riihimaki, 1991; Kelsey et al., 1990; Magora, 1973b) have found that the quality of the person-work-organisation relationship is influenced by many interdependent variables that in turn influence absenteeism. Some of the symptoms which have been found to be significantly associated with frequent unauthorised absences include: excessive alcohol consumption, smoking, obesity, a sense of loss of control, anxiety, irritability, boredom, headaches and the use of therapeutic drugs (Mets, 1994; European Foundation, 1995; Hawkins, 1987; Swartz et al., 1997).

Studies have shown that stress may have a strong emotional and psychological effect on a worker, but does not usually cause illness or serious disease (European Foundation, 1995). The responses to prolonged stress were found to be caused by a repetition of the same injuries caused by lack of recovery time and adequate preventative strategies (Gailliard et al., 1996). Stress was also shown to bring about changes to the bodies regulatory mechanism, damage to tissues and impairment of the immune system (European Foundation, 1995).

Studies (Hawkins, 1987; Bridger, 1995; Steer et al., 1978) have shown that the threshold at which absenteeism and symptoms of absenteeism occur is determined by a mismatch between demands made on an individual and his or her ability to cope with the demands and to maintain attendance motivation. The mismatch produces stress in the individual.

Women have been shown to react differently to stress from men (European Foundation, 1995). Absenteeism has been seen as only one of the different types of behavioural

change that may result from stress. Other behavioural changes are reduced work productivity, errors, increased smoking and drug abuse, poor social relations with family and friends and even suicide (Frankenhauzer, 1991; European Foundation, 1995). In some occupations women have a significantly higher risk of health problems due to psychological factors than men. According to a Swedish National Register Survey these occupation are in the manufacturing industry, among postal assistants, telephone operators and cashiers, in certain VDU jobs, and among nurses, nurse assistants, dental nurses and sewing workers (Synthesis Report of a panel of Experts, 1993).

2.1.1.2. Occupational Variables

Studies (Mets, 1994; European Foundation, 1995; Hawkins, 1987; Matrunola, 1996; Steers et al., 1978) have shown that occupational variables associated with absenteeism are closely interwoven with personal and organisational variables. Typical occupational variables include the type of work performed, the physical work environment, the organisation of production, day work and shift work, the type of supervision and relationships with supervisors. These studies have found that of the occupational factors the social factors seem to have the overriding influence on absence behaviour.

2.1.1.3. Organisational Variables

The general climate within an organisation seems to be considered the most important variable with regard to absenteeism in an organisation (Mets, 1994; Steers et al., 1978; Macfarlane et al., 1997; Kramer and Hafner, 1989; Weisman et al., 1981). This climate in turn is a product of the attitude of management towards its employees and the way that management attempts to achieve its goals. This is expressed in an organisation's policies and procedures, professional, personnel and medical services. Within the climate of an organisation a worker's attitude towards absenteeism is formed.

Organisational factors that have been reported as noteworthy include the physical work conditions (Macfarlane et al., 1997), the reputation that the organisation has amongst the

population (Mets, 1994), remuneration levels compared with other organisations in the area (Mets, 1994), and job satisfaction (Steers et al., 1978; Matrunola, 1996; Kramer and Hafner, 1989; Weisman, 1981). Where the organisational factors were regarded as favourable they seem to have been associated with low absenteeism. Higher paid subpopulations of workers have been shown to have a higher than average absenteeism, possibly because they could afford to be away from work for longer. Findings showed that if economic incentive was given in the form of sick pay benefits then absence frequency rates and overall sickness absence tended to be higher.

A relationship between absenteeism and job satisfaction has been reported in various studies (Steers et al., 1978; Matrunola, 1996; Kramer and Hafner, 1989; Weisman, 1981). Job satisfaction has been defined by Kramer and Hafner (1989) as a 'fluctuating attitudinal state of an individual derived from the perception that situational job factors important to the individual are present in the job'. Weisman (1981) in his study of nurses found work satisfaction levels were related to the patients' satisfaction with their care, indicating this to be a relevant issue in the 'climate of an organisation'. Matrunola (1996) found that nurses who were committed to their job, who felt more in control of their job and who felt that their work was challenging were less likely to become burnt out. Personal support was found to protect against many of the consequences of work and life stress.

A number of studies (Argyl, Gardner & Cofi, 1958; Covner, 1950; in Steers et al., 1978) have examined the relationship between variations in the size of the work group and absenteeism. In general, a positive linear relationship has been found between increases in work group size and absenteeism amongst blue-collar workers. An explanation for this finding was that increased work group size leads to lower group cohesiveness, higher task specialization and poorer communication (Steers et al., 1978). As a result it becomes more difficult to satisfy one's higher order needs on the job and job attendance becomes less appealing. This explanation may be more relevant for blue-collar employees than white-collar employees, since the latter group generally have more autonomy and control over their jobs and are in a better position to find 'alternative routes to intrinsic rewards'

(Steers et al., 1978).

Another variable seen to influence the level of satisfaction is the behaviour of an employee's superiors (Steers et al., 1978). Steers et al. concluded that leader behaviour has a more immediate impact on reactions to the job situation than on absenteeism itself, so that it appears that satisfaction is an intermediate variable in the leader-style-absenteeism relationship. Similarly, Steers et al. (1978) concluded that relationships with co-workers are strongly related to general job satisfaction, which, in turn, has been found to be related to absenteeism.

2.2. External Variables

2.2.1. Economic Variables

Unemployment can be considered an important and uncontrollable variable, the labour market itself being function of the state of the economy (Mets, 1994). Mets notes that in times of poor economic climate the level of absence is low. This is especially so for those worker groups who have a low level of skill and earnings. It is the high cost of living and the belief that their job security is threatened that produces the low level of absence.

2.2.2. Sociocultural Variables

The literature (Mets, 1994; Bridger, 1995; Shahnava 1991; Kapland, 1991) reveals that concepts of work, time, illness and sociocultural values also influence absence behaviour. Mets (1994) noted that in highly urbanised worker populations, even when originating from rural/tribal communities, such effects appeared to be minor. It is difficult to make firm conclusions about the influence on absence behaviour one might expect in a particular society or cultural group who have immigrated to the cities to find work. This may be because of adjustments made by the cultural group to 'acceptable absence behaviour' within the new society or cultural group.

2.2.2.3. Medical Variables

The prevailing and changing morbidity patterns and seasonal variation of disease incidence have received attention in literature (Mets, 1994; Gandhi, 1971) with regard to influencing sickness absence. These as well as socio-economic factors such as a lack of hygiene in poor living conditions; nutritional status and difference in exposure were found to play a role.

2.3. PAIN

2.3.1. The prevalence of musculoskeletal symptoms in supermarket workers

The work-relatedness of musculoskeletal pain was shown across studies to be controversial in most cases because there was little agreement that work was truly causative. Rather there was a 'broad consensus that various aspects of work were associated with symptoms and disability' (HSE, 1998). The type of work that was associated with an increased rate of musculoskeletal pain reports include: repetitive arm/hand movements (HSE, 1998; Kelsey et al., 1990; Linton, 1990); static work postures (Pheasant, 1991; Kelsay et al., 1990; Riihimaki, 1991; Yu et al. 1994; Kuorinka and Forcier, 1995); high work speeds (HSE, 1998; Burdof, 1992; Marras, 1993); stature (Pheasant, 1991; Mital et al. 1993); monotonous work (Linton, 1990; HSE, 1998); job dissatisfaction (Magora, 1973; HSE, 1998; Frymoyer et al., 1980) and psychological stress (Frymoyer et al., 1980; Andersson, 1979; Magora, 1973; Kelsey et al. 1990).

Studies performed specifically on supermarket checkout workers using laser scanners revealed that there were relationships between many types of symptoms of the upper extremity and both personal and occupational factors.

Harber et al. (1992) found cumulative exposure to scanning in the past two weeks to be most closely associated with arm symptoms, after having controlled for confounding factors such as age, sex and other personal factors. Harber et al. (1992) also found that

hours of working as a supermarket checkout operator and years on the job were significant contributors to upper extremity pain. Harber et al. (1992) concluded that certain repetitive motions were causes of upper extremity cumulative trauma disorder symptoms. Trends towards a relationship between wrist flexion and extension, lumbar flexion and pronation and hand-wrist-lower arm symptoms and carpal tunnel syndrome were noted. Harber et al. (1992) found there to be a dose response relationship between short-term or long-term exposure to checkout work and upper extremity disorders. The study found that the upper extremity symptoms were clustered in a small number of workers, but so were scores on personal illness, which may indicate a reporting effect rather than an exposure effect.

Ryan (1989) found a significant positive correlation between proportion of time spent standing and symptoms in the lower limb and foot. Ryan (1989) carried out a survey that aimed at determining the prevalence of musculoskeletal symptoms and identifying associated factors. A questionnaire was administered to all employees of seven supermarkets ranging in size from 15 to 171, with a response rate of 73%. One-third reported regular symptoms in some part of their body. Prevalence rates were calculated for each body part by department. This is shown in Table 4. The checkout department had the highest rate for almost all body areas. The lower back, lower limbs and feet were the body areas with the highest rates.

Nishiyama et al. (1973) found a combination of mechanical load from arm activities and psychological load from maintaining a relationship with the customer to be causative factors for neck, shoulder and arm syndromes. Data from the Nordic Musculoskeletal Questionnaire in Sweden revealed that checkout operators had a lower than average prevalence of lower back trouble, but higher than average rates for neck, shoulder and wrist symptoms (Ydreborg and Kraftling, 1988).

Baron et al. (1991) reported that the relative risk of shoulder pain in supermarket checkout operators was 3.9 when compared with other employees in the retail outlet. The

number of hours worked a week and scanning compared to cash register operation, were also identified as risk factors for shoulder pain in these workers.

Morgenstern et al. (1991) reported a 12% prevalence of hand/wrist symptoms characteristic of carpal tunnel syndrome in female grocery clerks. In this study both exposure and outcome were measured by means of a postal questionnaire. No associations with specific job related activities were identified. Ages, average hours worked per week, use of diuretics and years worked as checkout operator were reported to be positively associated with symptoms.

Buckle et al. (1986) compared 70 checkout operators with 342 workers from other retail stores and found that there was a dose-response relationship between 'time on feet' and lower leg and feet symptoms. Studies from Canada refer to constant standing, reaching, bending, and twisting as high risk factors (Wallersteiner, 1981; Stoffman and Sterling 1983; van der Doelen and McDonald, 1985).

Japanese researchers (Ohara, 1976; Sakurai and Miwa, 1975) have demonstrated a high percentage of shoulder and neck symptoms in checkout operators and have shown a relationship with cash register systems and operation.

Table 1**Prevalence (%) of symptoms by department and body area (Ryan, 1989)**

Dept	Head	Neck	Upper Limb	Wrist Hand	Upper Back	Lower Back	Lower Limb	Ankle Foot	Total *
Checkout	4.1	7	8.7	7.4	8.3	17.4	10.3	11.6	75
Grocery	1.9	3	5	3.8	3.7	8.7	3.8	2.3	32.3
Night fill	2.8	1.4	4.3	8.6	5.7	7.1	0	1.4	31.4
Speciality	3.6	4.9	5.5	4.5	3.6	10	2.9	2.9	28
Management	1.9	2.6	3.9	1.9	1.3	5.2	4.5	302	24.5
Total	3	4.3	5.8	4.9	4.5	10.5	4.9	4.7	42.7

* Rate is per 10,000 person hours

2.3.2. Musculoskeletal risk factors for back pain in supermarket checkout operators

Reviewers of work-related back pain have presented conflicting conclusions regarding exposure- outcome relationships. No firm conclusions regarding work-relatedness have been made. Back pain is not a complaint of workers alone but is shown to have a high life time prevalence of 60-90% in the general working age population (Nachemson, 1976; Burton, 1997).

There are many epidemiological reports that link heavy, strenuous work with back pain. However, this is not universally reported and there are differences in the definitions of back pain (or injury) and workload (Burton, 1997). Burton et al. (1995) found that exposure to occupational physical stress seemed to be detrimental as it reduced the 'survival time' to the first onset of low back pain. Recurrence was associated with the time since the first onset, but persistent pain was not. Burton (1997) also found that sports participation was a risk if occupational hazards were high.

Burton (1997) noted that studies were not entirely consistent in reports of an association between heavy work and absenteeism. This was expected because of the progressive reduction of occupational physical stressors over recent years because of the combined effects of increasing mechanisation and ergonomics driven legislative procedures. Burton also found no evidence that back pain had decreased and noted that lower back pain continued to grow exponentially. Burton concluded that biomechanics/ergonomic considerations may be related to the first onset of lower back pain, but there is not enough evidence that 'secondary control' based solely on these principles will influence the risk of recurrence or progression to chronic disability.

Recent evidence (Symonds et al., 1996; Burton, 1997; Burton et al., 1995) has indicated the influence of psychosocial factors on low back disability was 'as great, if not greater' than ergonomic aspects' and negative attitudes and beliefs were noted as 'likely to be related to absenteeism'. Symonds (1996) found an increase in general absence related to a perception of poor social support, and to high mental stress.

2.4. Anthropometrics, variability and musculoskeletal risk factors

Abeysekera and Shahnnavaz (1988) compared variations in the body size between workers in industrialized countries, and those in industrially developing countries. Today industrially developing countries, like South Africa, depend largely on the importation of manufactured goods. Unfortunately the unavailability of reliable anthropometrics data for many countries like South Africa often lead to the mismatches that take place between the users and the imported goods. The question remains if foreign suppliers would adjust their designs to fit every country they export to, however even increasing the range of adjustability of their designs would help cater for more of the South African population.

A product designed according to the correct ergonomic principles would be able to satisfy the requirements of 90% of the potential user population. Abeysekera and Shahnnavaz (1988) concluded that goods that accommodate 90% of users in industrialised

countries were only physically compatible to 57% of South African users (and as low as 13% of Vietnamese users).

2.4.1. Musculoskeletal risk factors

Musculoskeletal pain has become highly problematic in industrialized countries (Kuorinka and Forcier, 1995). Musculoskeletal pain has been shown to account for 30% of work time lost due to sickness absence (Westgaard and Aaras, 1984)

Kuorinka and Forcier (1995) define a risk factor as: “ an aspect of personal behaviour or lifestyle, and environmental exposure (including work) or an inborn or inherited characteristic, which, on the basis of epidemiological evidence is known to be associated with health-related conditions considered important to prevent. The term ‘risk factor’ involves the following meanings:

- An attribute or exposure that increases the probability of occurrence of disease or other specified outcome.
- A determinant that can be modified by intervention, thereby reducing the probability of occurrence of disease or other specified outcomes.

In order to classify a variable a risk factor it needs to be measured. In the next section two types of measurements are mentioned which can be used to assess a musculoskeletal risk factor.

2.4.2. Types of Anthropometrical Data

2.4.2.1. Static (Structural) Data

These are measurements made from one clearly defined anatomical mark to another, with the subject in a stationary position. Furniture manufacturers and fashion houses, as well as vehicle and equipment manufacturers require these data. Bridger (1999) notes that

although scanning is generally considered a dynamic task it is possible to make use of static measurements in instances where the cashier is highly constrained.

2.4.2.2. Dynamic (Functional) Data

These data are needed to design space and equipment so that it is well suited to the user requirements when performing tasks such as reaching. In other words these are measurements of the range of movements of the body parts.

In this study only static data were measured, to obtain a database of the supermarket chain cashiers in the Western Cape. Personnel trained in ergonomics to investigate physical mismatches and their consequences in a working environment can use this anthropometrical data.

Barkla (1961) and Pheasant (1982) developed a technique to estimate the physical dimension and ranges of adjustability in the design of products. This method is known as the RASH method (Rapid Anthropometrics Scaled for Height). Even though tables of anthropometrical data variables are available for some populations, these are often incomplete and not up to date. In many instances one can also not assume that the dimensions of the target populations are representative of the local population. To use this method, the stature measurement of the target population should be known. A set of scaling factors is then derived from a reference population and used to estimate the dimensions needed for the specific design. This technique was used for the purposes of this study.

2.5. Conclusion

The literature review tried to show the various influences on employee attendance behaviour. Briefly stated, the literature review suggests that an employee's attendance is largely a function of two important variables, that is an employee's motivation to attend

and an employee's ability to attend both which are affected by an associative network of variables both internal and external to the working environment.

The work-relatedness of musculoskeletal pain was shown across studies to be controversial in most cases because there was little agreement that work was truly causative. Rather there was a broad consensus that various design aspects of the work-environment were associated with symptoms of disability. Investigators found evidence which indicated that psychosocial factors; negative attitudes and beliefs; poor social support and high mental stress were positively related to increased absenteeism and may have an influence on absenteeism which is 'as great, if not greater than ergonomic aspects'. Symptoms of pain may be a normal consequence of life, but if the worker erroneously believes that the job is to blame, there is the possibility that psychosocial factors outweigh other factors at this point. Inappropriate beliefs about the nature of their problem and its relation to work may develop fear-avoidance strategies. Workers then begin to function in an inefficient manner which may drift into chronic disability.

3. METHOD

3.1. Study Design

The study design used was a cross-sectional analytic study. The author was able to obtain a sample of 28% of cashiers in the study supermarkets in the Western Cape. These cashiers consisted of those who agreed to take part in the study.

A cross-sectional analytic study was chosen for this study as it is easy and rapid to accomplish and does not require a follow up on the study population over time. However, it is not able to establish a temporal sequence of events necessary for drawing causal inferences (Mausner & Kramer, 1985). The use of case-referent studies was likely to be hindered by the unavailability of medical and other records.

3.2. Subjects

98 subjects, 95 females and 3 males, participated in the research divided amongst 8 supermarkets chain stores in the Western Cape. Participants in this study were cashiers who performed checkout activities for 45 hours a week from 8 am to 5 pm and from 9 am to 6 pm for six days a week. Packers and part-time cashiers were excluded from the study. Absenteeism and lost days due to musculoskeletal pain among those cashiers who had taken maternity leave in 1997 were excluded, since discrimination between days lost due to musculoskeletal pain and days lost due to pregnancy related symptoms, such as lower back pain (Kelsey et al., 1990), cannot be made.

The cashiers from the 8 different supermarkets were informed by their supervisors about the study one week before the interviews were to commence. Groups of cashiers were approached during their lunch breaks and asked to participate in the survey that involved an on-site 15-minute interview and an anthropometrics survey. Those who agreed to take part in the survey were interviewed confidentially away from other workers.

3.3. Sampling Strategy

Supermarkets that were used in this study were selected for the differences in checkout design as well as accessibility from the University of Cape Town.

The supermarkets vary in size, some employing 9 full time cashiers and others as many as 38 cashiers. The total number of cashiers in the Western Cape at this supermarket chain was reported to be approximately 500. Sample size was determined in advance in accordance with the guidelines presented in the NIOSH Occupational Exposure Sampling Strategy Manual (Leidel et al., 1977). The guidelines presented ensure that an acceptable narrow 95% confidence level is maintained around the prevalence estimates of reports of musculoskeletal pain and absenteeism. A number of tables are available in the manual to enable the selection of an adequate sample size. An example of the selection table used to determine the number of cashiers to be randomly sampled is presented below.

Table 2 Size selection table showing sample size required

Size of Group (N)	7 to 8	9 to 11	12 to 14	15 to 18	19 to 26	27 to 43	44 to 50	51 +
Size of Group Required (n)	6	7	8	9	10	11	12	14

Each cashier that participated in the ergonomic survey also completed a questionnaire (see Appendix A). Due to the lack of time available and the impracticality of removing uniforms in the cafeteria, cashiers were not requested to remove their uniforms, only their shoes. Furthermore, cashiers preferred not to take the questionnaires home overnight the reasons being that they did not want to spend time at home on subjects related to work.

Table 3 **Number of participants from each supermarket**
(N = size of group; n = number sampled for interviews)

Supermarket	N	n
B/V	11	11
E/R	9	8
W/F	12	10
S/P	8	4
K/W	37	23
T/V	13	13
G/W	12	10
C/S	38	22
Total	140	101

3.4. Questionnaires

The questionnaire was divided into sections dealing with musculoskeletal pain, usability of checkout facilities, stress and job satisfaction. Each section was made up of questions from various published questionnaires that had been tested by the respective author for reliability and validity (see below).

3.4.1. The Pain Questionnaire

The core items of the questionnaire were obtained from Kuorinka and Forcier (1995). After pre-testing it was found that cashiers experienced difficulty in assessing which level of musculoskeletal pain they experienced. A short explanation was attached to each level of pain, which can be seen below:

1= No pain felt

2= Feel pain on busy days

3= Pains at the end of the day

4= Pains when doing certain work

5= Pains all the time

Areas of musculoskeletal pain were indicated by subjects on a body diagram and then grouped by coding into 10 different anatomical regions i.e. neck, shoulder, wrist, arm, fingers, upper back, lower back, thigh/knee, lower leg, ankle/foot. See Appendix A.

In addition to musculoskeletal pain, the questionnaire aimed to elicit information in the following areas (See Appendix A):

- Duration of employment
- Discomfort in any body area
- Age
- Various health problems
- Injury outside or during work.

A differentiation was made between discomfort and pain in the questionnaire.

Discomfort was used to indicate possible strain and the development of discomfort was also seen to be an indicator of the early stages of a musculoskeletal disorder, especially if the cashier had experienced many episodes of discomfort and the discomfort had extended after the work shift (Kuorinka and Forcier, 1995). Kuorinka and Forcier also stated that most work-related musculoskeletal disorders have pain amongst their symptoms in the later stages of development.

Correlation matrices were used to reveal significant relationships between musculoskeletal pain and: absenteeism, musculoskeletal and emotional stress, job satisfaction, previous injury, age, duration of employment, health problems, pressures of dependants, stressful relationships, perception of supervision and anthropometric dimensions. Similarly correlation matrices were used to identify relationships between absenteeism and the above variables. The significant correlates were then put into a multiple regression equation to model the relationships between the risk factor variables and musculoskeletal pain. The same was done with absenteeism as the outcome.

3.4.2. Job Satisfaction and Stress Questionnaire

Questions evaluating psychological stress and musculoskeletal effects of stress on employees were obtained from the course notes of the Exercise Teachers Association, drawn up by Dr Linda Haliday, 1997. The questions have been tested for reliability and validity (Haliday, 1997) and are currently in use by psychologists and Personal Trainers in order to evaluate stress sensitivity in various areas. Both psychological and musculoskeletal effects of stress were determined by measuring eleven factors on a four-point scale. It must be noted that the eleven factors of musculoskeletal stress are physiological indicators that a person may be stressed and not measures of physical stress placed on the musculoskeletal system by being a cashier, and so these indicators may not necessarily relate to pain in other parts of the body.

Data were also collected in the following areas:

- job satisfaction
- number of children under the age of 10
- choice of coping mechanism
- aspects of the working environment which most stressed the cashier.

3.4.3. Usability Questionnaire

The questionnaire (Appendix A) aimed to identify the problems and difficulties associated with the present design of the checkout and associated equipment. Data were collected about the checkout design and preference of working positions.

3.5. Anthropometrical Measurements and the Physical Dimensions of the Workstation

An ergonomic inspection was made of the supermarket checkout facilities. This covered inspection of the seating arrangements and their relationship with the work surface of the checkouts.

Descriptions of the equipment (e.g. footrests) available at the checkouts were recorded along with important dimensions. Measurements taken included work surface heights, clearances for legs underneath the work surface, reach distances, seat characteristics and relationships with the work surface.

The anthropometrical dimensions of these checkouts were compared with the cashiers, reports of musculoskeletal pain using correlation matrices. The body dimensions were also intended to be a guide for the design of future workstations. The body dimensions considered relevant are shown in Table 4. They were considered relevant because of the potential problems they could help to uncover.

Table 4

Potential Problem	Dimensions Measured
1. Pushing/pulling loads	Grip reach, Stature, Weight
2. Inadequate legroom	Stature, Standing hip height, Weight
3. Low Work Surfaces	Stature, Standing elbow height
4. High Work Surfaces	Stature, Standing elbow height, Grip reach
5. Seat	Standing hip height, Abdominal girth, Buttock-popliteal length, Buttock-knee length Hip breadth
6. Lifting loads	Stature, Abdominal girth, Grip reach

The anatomical postures adopted during the anthropometrical measurements were standardized by asking the cashier to stand against the wall with their ankles, buttocks, upper backs and head touching the wall (Botha, 1997).

Correlation matrices were also used to reveal significant relationships between the dimensions of workstations and the prevalence of musculoskeletal pain.

The measuring instrument was limited to the use of a tape measure. The tape measure selected was flexible and inelastic with measuring scales on both sides, in inches and centimeters. The tape measure also had a spring-retractable mechanism that was activated by pressing a button.

There were a few errors that had to be considered when using the tape as measuring instrument. The tension applied to the tape by the measurer has been shown in previous studies (Lohman et al., 1991) to affect the validity and reliability of the measurements. The measurer had to be sure that the retraction spring tension did not affect the measurement.

When measuring a circumference, in this case Abdominal Girth, the author had to be sure to hold the tape snugly around the body part, but not too tight as to compress the subcutaneous adipose tissue. The measurer also had to be careful that the tape did not indent the skin. Another cause of poor reliability that has been documented was the improper positioning of the tape, which should be perpendicular to the floor. Furthermore, taking measurements at various phases of respiration had been shown to lead to errors in measurement abdominal girth.

3.6. Statistical Analysis

Significant relationships were sought through the use of correlation matrices. A direct relationship was sought between the dependent variables pain and absenteeism where ($p < 0.05$).

To avoid unmanageable tables the independent variables selected were significant correlates of the dependent variable. Their correlates were put into a regression analysis to test for a significant relationship. Not more than 10 possible variables were inserted into the equation (Statsoft, 1995).

The major conceptual limitation of regression techniques is that one can only ascertain relationships, but not be sure about the underlying causal mechanisms. The use of the multiple regression technique does allow the question to be answered "what is the best predictor of".

It was assumed that the relationships between the variables were linear. Fortunately, the multiple regression procedure is not greatly affected by minor deviations from the assumption of linearity. To avoid distortions in the results a test was run before each multiple regression equation to examine the distribution of the dependent variable across the independent variables. An observation was considered an outlier if it fell outside the mean plus-minus three standard deviations. Outliers were removed from the data and the regression equation repeated until the best fit was achieved. For each equation, the 'normal probability plot of residuals' was examined for any indications of gross violation of the linear assumption

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4. RESULTS

4.1. Checkout Design

The checkout designs evaluated represent a range covering both older and more contemporary designs with the same scanner technology. Each starts with a produce delivery system, followed by a produce-checking method and then exit system. The delivery system is a conveyor belt; the price checking method is a cash register or a laser scanner (vertical or flatbed). The exit systems are chutes, which vary in angles across supermarkets. The cashiers choose either to sit facing across the flow of goods or facing the delivery of flow, or to sit midway between the two positions so as to operate the till whilst scanning the goods. Below are shown the various cashier systems:

Figure 1 The newer style checkout system found at the C/S supermarket store

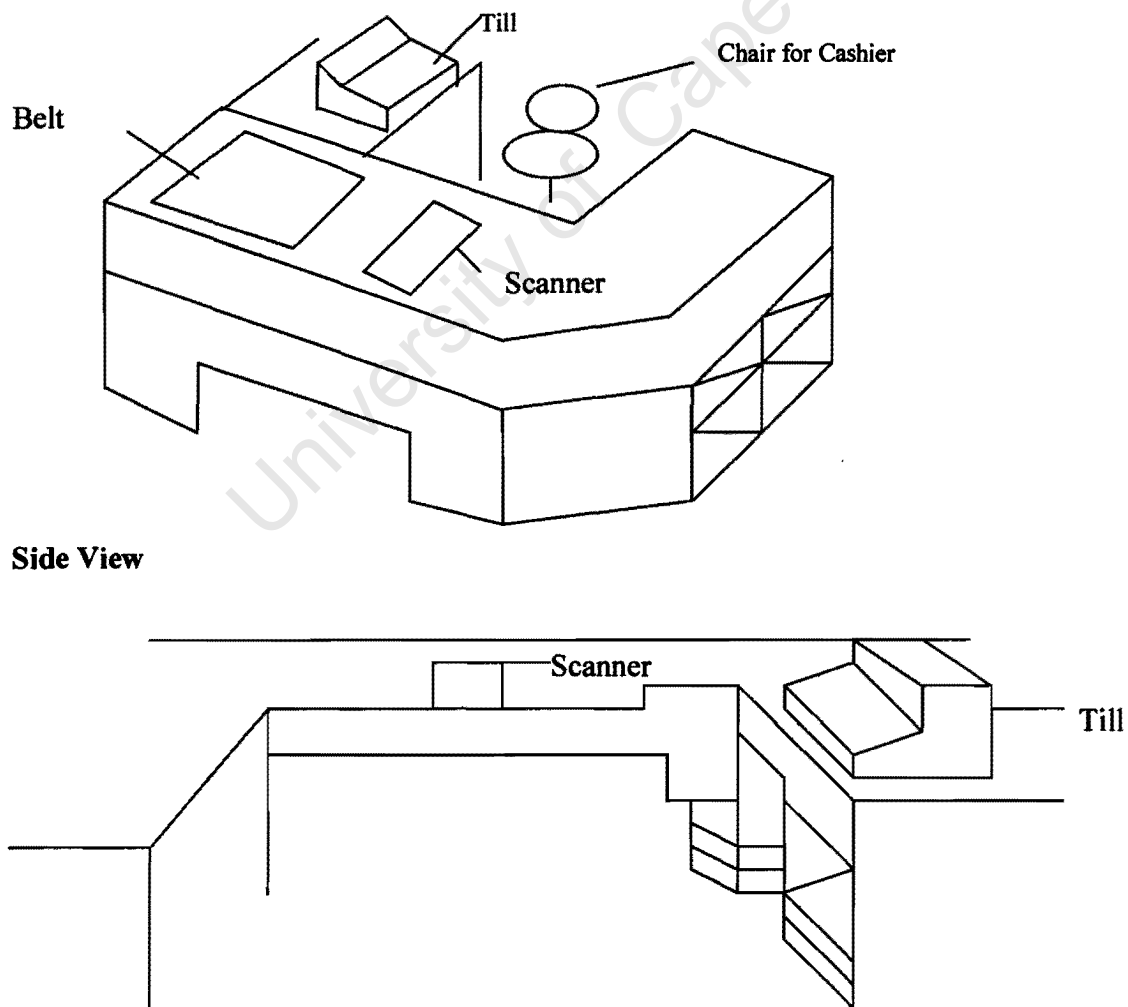
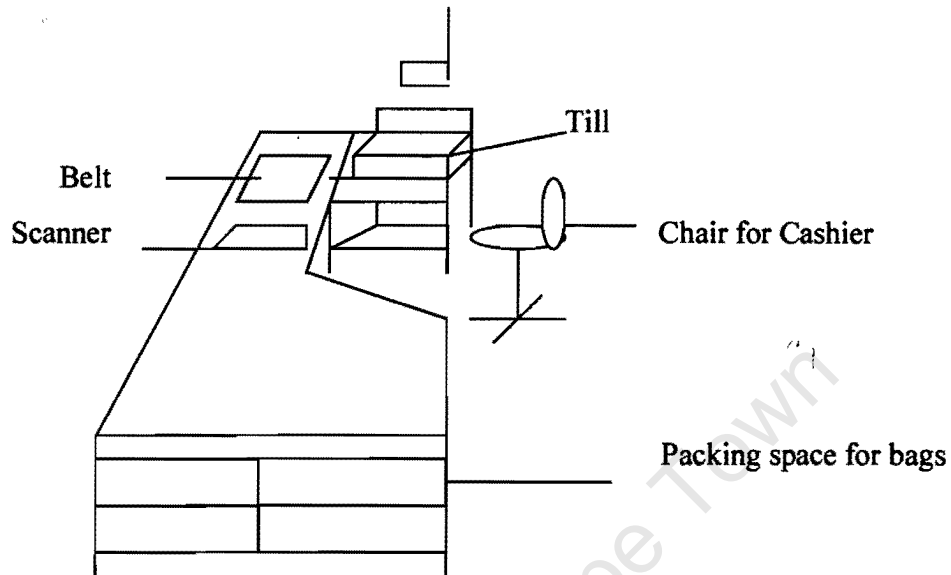


Figure 2 The older style of checkout occurring at the other supermarket stores



The older style of checkout can further be divided into different variations of this style with different measurements for each supermarket store.

Figure 3 Supermarket Stores: K/W, B/V, T/V and E/R

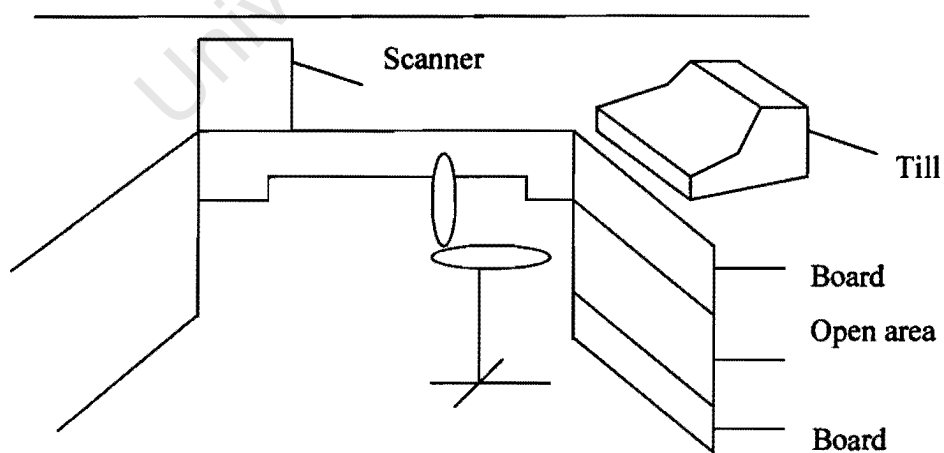


Figure 4 Supermarket Store: G/W

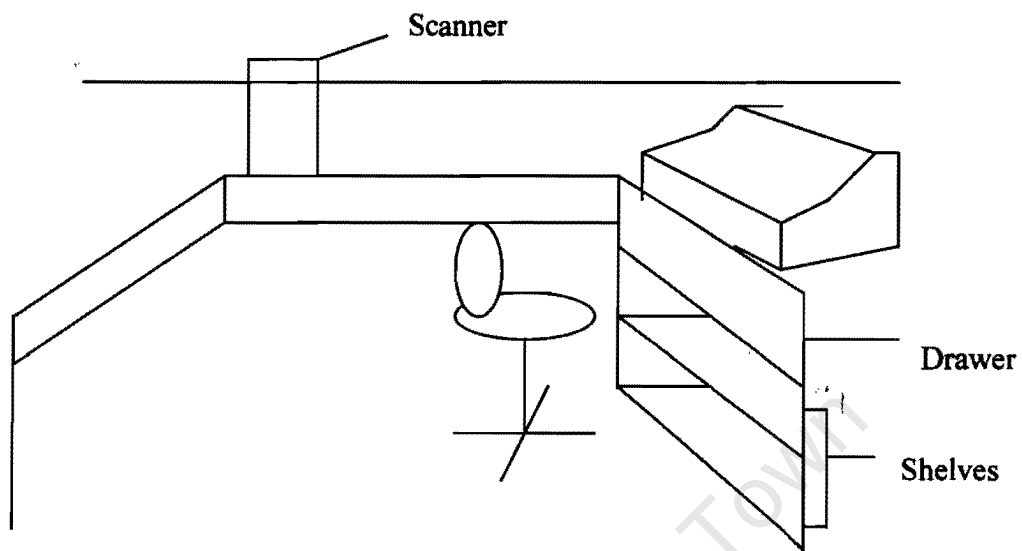
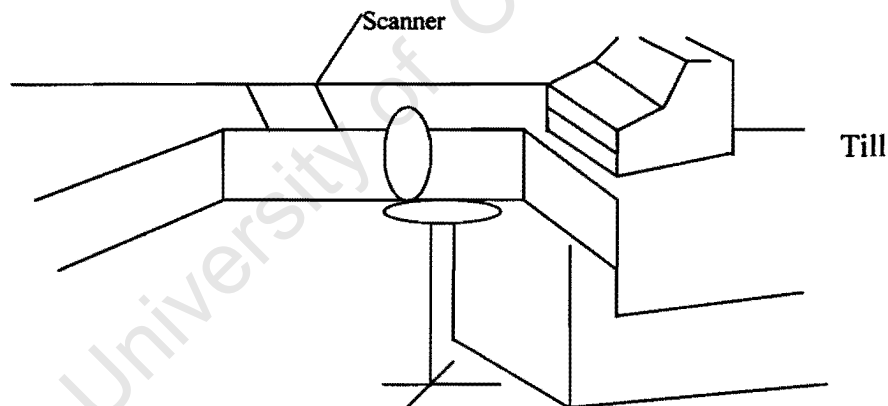


Figure 5 Supermarket Store: S/P and W/F



4.2. The Cashiers' Task

The task of the operators was examined. The laser scanners and computing equipment at the checkouts were manufactured by NCR (National Data Systems, from America). The design specification was from a manufacturer based in the UK.

Information was obtained by direct observation, by workplace measurement and photographic records, by formal interviews with the operators and informal discussions with both the supervisors and staff. Figure 6 shows the actions performed at every stage of the cycle.

Figure 6 The sequence of functions of the cashiers task

1. Search items.
2. Pick up item with left or right hand.
3. Inspect for positioning of code.
4. Inspect for identical items amongst load.
5. Pass item over scanner with left or right hand.
6. Check that scanner takes the code.
7. Key in the code if necessary.
8. Check to see if there are any items not weighed.
9. Send packer to weigh fruit/vegetables.
8. Receive price information.
10. Key in price with right hand.
11. Key in number of identical items.
12. Place remainder of identical items in packing area.
13. Select another item to be scanned.
14. Was scanning successful? Yes/No? If no, scan again or key in price.
15. Place item in packing area.
16. Inspect – was this the last item? If yes, commence next step, if no, select item to scan.
17. Press Total.
18. Tell customer the cost.
19. Wait for payment.
20. Receive payment.
21. Key in amount received.
22. Determine change.
23. Cash money, give change.

4.3.5. Pain Areas

Table 8 Cashiers (%) who reported pain by areas (n = 98)

Pain Area	Percentage cashiers with pain
Neck	5.1%
Shoulder	20.5%
Arm	1%
Wrist	1.6%
Upper Back	6.4%
Lower Back	1.7%
Thigh/Knee	1.6%
Lower Leg	0.3%
Ankle/ Foot	1.6%

4.3.6. Pain Categories

Table 9 presents pain categories and the percentage of cashiers who reported this type of pain from the eight supermarkets. 4.8% of the cashiers did not respond to this section. 3.8% reported that they did not feel any pain. However this percentage does not take into account other symptoms of strain such as numbness, aching, burning, swelling and stiffness.

4.3.3. Gender and “Race”

The sample was homogeneous with respect to gender and “race”. 97% of the cashiers who took part in the survey were “coloured” and 98% were female.

4.3.4. Anthropometrical Data

Table 7 Anthropometrical Variations of Cashiers (n = 98)

Unit	Mean	Std Dev	1 st Quartile	2 nd Quartile	3 rd Quartile	4 th Quartile
Weight (Kg)	68.43	17	44	55	78	130
Reach (m) *	0.6	0.06	0.44	0.57	0.65	0.74
Abd (m)	.95	0.28	0.6	0.8	1	3.03
SHH (m)	0.96	0.06	0.86	0.93	1	1.3
SEH (m)	1	0.06	0.66	0.96	1.04	1.2
Stat (m)	1.59	0.073	1.42	1.54	1.64	1.8
Age (Yrs)	30.8	6.73	0	27	34	47
TimeonJob (y)	3.83	0.42	-	-	-	-

KEY: Abd = Abdominal Girth; SHH = Standing Hip Height; SHE = Standing Elbow Height; Stat = Stature; * = Forward Grip Reach; Std Dev = Standard deviation

There appeared to be no permanent cashiers working for a period less than 2 years at the supermarket chain. This was due to the policy of employing cashiers on a part time basis or as a relieving cashier (from another department, mostly packing) for the first two years before taking them on as permanent staff. 2% had been working on a permanent basis for 2 years and 12.2% had been working as a permanent cashiers for 3 years, while 84.6% had been working permanently for more than 4 years

4.3.2. Childcare options of cashiers who have children

Table 5 presents the childcare options used by cashiers who had one, two or three children under the age of 10 years. The percentage of cashiers who had children was 50% of the sample.

Table 5 Child care used by cashiers with children under 10 years of age (n= 49)

Child Care: No of children	Mother in Law	A Friend	A Crèche	At Home with/ without sibling
1	38%	14%	20%	28%
2	45%	13%	21%	21%
3	16%	34%	16%	34%

Table 6 Mean days absent per year of cashiers with children under 10 years of age (n = 49)

No of children	Mean days absent	Standard Deviation	95%confidence interval
1	8 days	17.8	4.4 – 11.6
2	7.2 days	21.8	2.7– 11.1
3	4.3 days	8.9	2.5 – 6.2

Cashiers who had three children appeared to be absent on average half the time of cashiers who had one or two children. This may be due to the tendency shown in table 5 of cashiers to depend on siblings to take care of one another. Table 5 showed that cashiers who had three children chose to leave their children at home or with a friend more frequently than cashiers who had one or two children.

24. Obtain and give receipt.

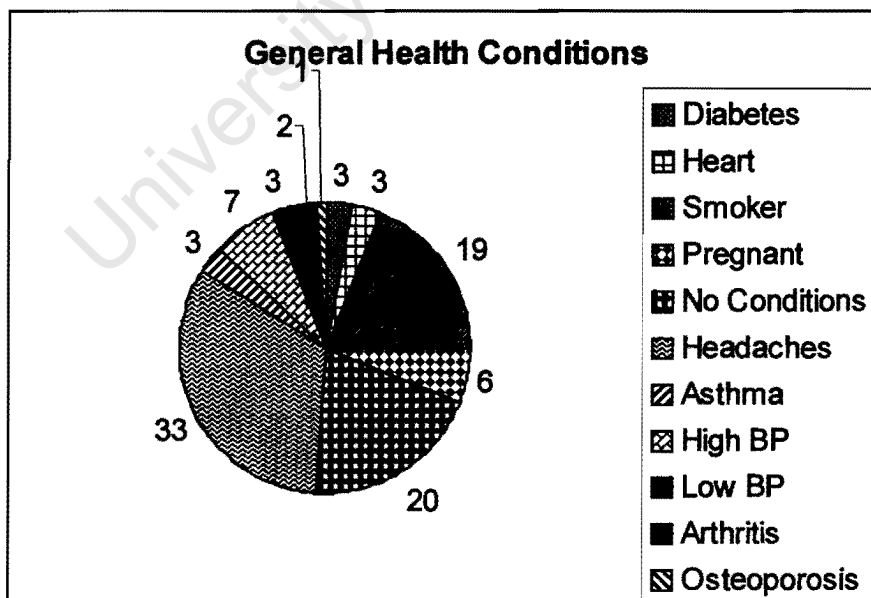
4.3. Descriptive Overview of Personal Characteristics

4.3.1. Health Conditions Reported

The percentage of various conditions reported by the sample ($n = 97$) shows a relatively large proportion of cashiers who experience regular headaches (33% of all conditions), as well as a proportionally large percentage that smoke (19%). In comparison, the other conditions seem to occur in small proportions, respectively: Diabetes (3%), Heart Problems (3%), Pregnant (6%), Asthma (3%), High Blood Pressure (7%), Low blood pressure (3%), Arthritis (2%) and Osteoporosis (1%). 20% of the cashiers reported no health conditions.

All the conditions that were mentioned by cashiers during their interview appear below and the percentage of occurrence is indicated in the Pie Chart (Figure 7)

Figure 7 General Health Conditions Reported by Sample (% of all conditions)



* A respondent may report more than one condition

Table 9 Cashiers (%) who reported various categories of pain in the different stores

Categ	T/V n=12	E/R n=8	B/V n=11	G/W n=10	K/W n=22	C/S n=21	S/P n=4	W/F n=10	Total n=98
1	0	14%	0	0	4%	0	0	0	2%
2	16%	42%	30%	20%	22%	20%	0	37.5%	24%
3	31%	14%	30%	10%	22%	0	50%	37.5%	24%
4	30%	0	0	40%	14%	15%	25%	13%	18%
5	24%	28%	40%	30%	36%	55%	25%	12.5%	32%

KEY: Categ = Categories: 1= Cannot feel any pain; 2= Feel pain on busy days; 3= pains at the end of the day; 4= pains when doing certain work; 5= pains all the time. T/V = Tygervalley; E/R = Eerste Rivier; Bville = Bellville; G/W = Goodwood; K/W = Kenilworth; Const = Constantia; S/P = Sea Point; W/F = Waterfront.

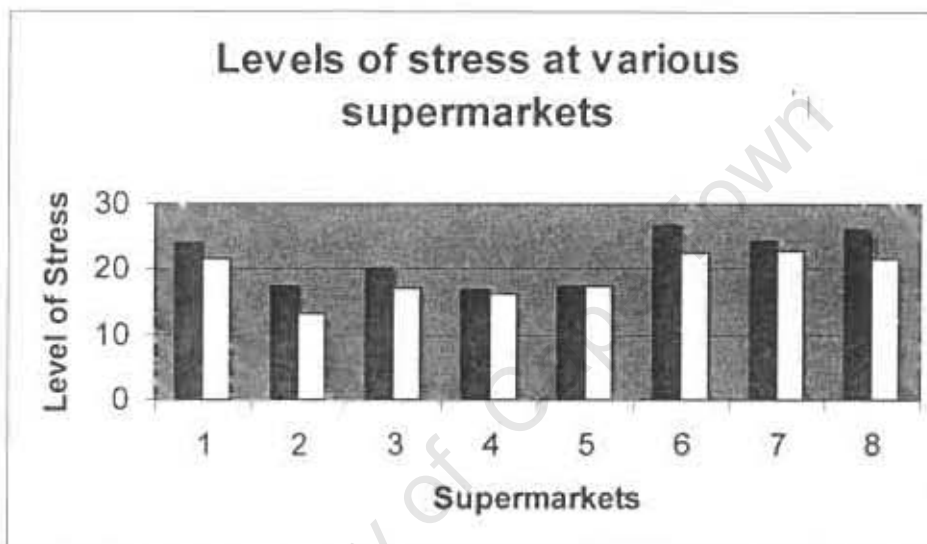
89% of the sample reported pain. Overall 24% reported feeling pain on busy days only, with E/R (42%), W/F (37.5%) and B/V (30%) reporting the highest prevalence. 24% reported feeling pain at the end of the day of which S/P (50%), W/F (37.5%), T/V (31%) and B/V (30%) reported the highest prevalence of pain. 18% reported feeling pain when performing certain work (see section 3.2.4. 'Reported causes of musculoskeletal pain'), with G/W (40%) and T/V (30%) exceeded the other supermarkets. However, the largest proportion of the sample (32%) reported consistent pain. In this category C/S (55%), B/V (40%), K/W (36%) supermarkets had the highest percentage of cashiers reporting consistent pain. The other supermarkets also reported over 20% of cashiers who experienced pain in this category, except for W/F (12.5%).

4.3.7. Stress Levels

Musculoskeletal and Emotional stress levels at the different supermarkets were measured using an eleven-question scale with the highest possible score for each question being 4 (see questionnaire in Appendix A). In each supermarket the scores for

each question response of each cashier who completed the stress questionnaire were added together and divided by the number of cashiers to obtain an average stress level. The total possible score on each eleven-point question scale was forty-four.

Figure 8 Graphical comparison between the average stress levels at the various supermarkets



Key: 1= Tygervalley, 2= Goodwood, 3= Eerste Rivier, 4= Bellville, 5= Waterfront, 6= Sea Point, 7= Kenilworth, 8= Constantia. Series 1= Musculoskeletal Stress, Series 2= Emotional Stress

Figure 8 shows the average musculoskeletal and emotional stress levels at the various supermarkets. The results suggest a correlation between musculoskeletal and emotional stress across the various supermarkets. The score for musculoskeletal stress was higher than or equal to the score for emotional stress in every supermarket.

4.3.8. Satisfaction Ratings

The satisfaction indices for the four job context factors (pay, job security, supervisor and co-workers) were calculated on a scale of one to three for each supermarket, with 1 representing 'satisfied', 2 representing 'content' and 3 representing 'dissatisfied'. Cashiers were in general 'content' with the organisational aspects of the environment

Table 10 Average satisfaction ratings at each supermarket (n = 98)

	Total	Pay	Job Security	Co-worker	Supervisors
Tygervalley	2.07	2.07	2.07	20.7	2
Goodwood	2.2	1.8	1.3	1.5	2.2
Eerste Rivier	2	1.28	2.85	1.57	2.14
Bellville	2.45	1.9	1.18	1.45	1.45
Waterfront	2.14	2.25	1.37	1.5	1.5
Sea Point	3	1.25	1	1.5	1.25
Kenilworth	1.86	2.13	1.8	1.4	1.7
Constantia	2.38	2	1.7	1.7	1.8

Cashiers were also asked which aspects at work and home “stressed them out the most” and which strategies they would choose to cope with stress.

The results showed the following factors to be most stressful, in rank order:

1. Dealing with customers 41%
2. Dealing with supervisors 18%
3. Personal matters 12%
4. Family matters 11%
5. Dealing with co-workers 8%
6. Dealing with management 6%

The strategies to cope with stress were reported as follows:

- | | |
|---|-------|
| Taking sick leave (without certificate) | 42% |
| Seeing their own doctor | 23.5% |
| Speak to a friend | 16.3% |
| Speak to the nurse or supervisor | 9% |
| Try to forget about the problem | 7% |

The average absent days for cashiers who indicated they were dissatisfied, compared to those that were satisfied showed no significant difference. Cashiers were allowed 36 days absent leave (with a certificate) over a three-year period. Both satisfied and dissatisfied cashiers were absent for an average of 12 days in the year (1997) that absenteeism was measured.

It was expected that those that were dissatisfied in their jobs would take more sick leave. Factors that may have affected the cashiers' decision to take sick leave may have been:

- That they did not get paid on the days they did not work, or
- The amount of sick leave allowed had been used up.

4.4. Pain Analysis

4.4.1. Average time that the pain lasts

Table 11 The percentage of cashiers who reported musculoskeletal pain for certain amount of time in a particular body area (n = 98)

	Neck	Shoul	LB	UB	Arm	Wrist	Fing	T/K	LL	F/A
< 1hr	3	13	7	1				1	1	
1-24h	9	30	31	10	2	3		3		1
1w-1m	4	9	9	2		1				1
1-6m	1	4	2		1					
> 6m		3								
1yr		2	2							3

Key: Neck = Neck; Shoul = Shoulder; LB = Lower Back; UB = Upper Back; Arm = Arm; Wrist = Wrist; Fing = Fingers; T/K = Thigh/Knee; LL = Lower Leg ; F/A = Foot/Ankle

Most of the pain experienced in the ten body areas lasted 1–24 hours, with the highest percentage of pain occurring in the shoulder, lower back, upper back and neck areas. It

is important to note that cashiers selected more than one area in which they experienced musculoskeletal pain. Pain in the shoulder and lower back showed a tendency to persist over longer time periods than pain in the other areas. The occurrence of most of the reports of pain in the upper extremities was expected because of the highly repetitive motions performed with the hands. Observation of the data brings to light that a large proportion of complaints of musculoskeletal pain last between 1-24 hrs, which seems to mean that these complaints disappear at the end of a days work when the cashiers are allowed to rest from the usual cashier operations. Data also show a smaller proportion of the data to be spread across the < 1hr and the 1w-1m period. It is not possible to speculate what the possible causes of this pattern are, because there may be many different reasons for the symptom of musculoskeletal pain in a small percentage of a sample.

Differences were found between the various supermarkets.

Table 12 Percentage of cashiers at each supermarket that experience pain in any body part for a certain amount of time

Time	T/V n=12	G/W n=10	B/V n=11	S/P n=4	W/F n=10	K/W n=22	Const n=21	E/R n=8
< 1hr	15	30	28	50		31	27	10
1-24hrs	98	20	100	100	100	100	95	50
1w-1m	15	60	0	0	37.5	27	450	0
1-6m	7	30	0	0	0	9	0	0
>6m	7	0	10	0	0	4	0	0
1yr	23	20	0	0	0	0	10	0

KEY: T/V = Tygervalley; G/W = Goodwood; B/V = Bellville; S/P = Sea Point; W/F = Waterfront; K/W = Kenilworth; Const = Constantia; E/R = Eerste Rivier

It is important to note that cashiers reported pain in more than one area at a time. For example, 98% of the sample of cashiers at T/V reported musculoskeletal pain in some

area of their body that lasted 1 – 24 hours, while 15% of cashiers had pain in other parts of their body that lasted 1 week to 1 month. Similarly for the other rows.

The differences between the supermarkets became apparent when looking at musculoskeletal pain reported in the different supermarkets.

- Shoulders: for pain that lasted from 1-24 hrs Kenilworth (45%), Sea Point (50%) and Waterfront (37.5%) had proportions above 30%
- Lower back: Sea Point (50%), Waterfront (50%), Kenilworth (45%) and Constantia (40%) rated the highest
- Upper back: Sea Point (25%) followed by Waterfront (12.5%). The rest revealed percentages below 15%.

However, in a time span of 1 week – 1 month, the following supermarkets had the highest proportion of cashiers experiencing pain:

- Shoulders: Goodwood (20%) and Constantia (20%)
- Lower Back: Goodwood (30%) and Constantia (15%)

4.4.2. Recurrence of pain

Table 13 Frequency (%) of reported pain during the previous 12 months

Time	Neck	Shoul	LB	UB	Wr	Arm	T/K	L Leg	A/F
Constant	3	13	9	2	2	2	1	0	3
Daily	6	25	27	9	3	2	3	1	1
Weekly	4	13	12						1
Monthly		4	6						
Every 2-3 months	1	0		1					
Every 6 months		1		1					

Key: Shoul = Shoulder; LB = Lower Back; UB = Upper Back; Wr = Wrist; Arm = Arm; T/K = Thigh/Knee; L Leg = Lower Leg; A/F = Ankle/Foot.

Nine out of ten areas were characterised by recurrent pain, with daily pain being reported in all nine areas. Shoulder and Lower Back areas were most likely to be affected by daily pain, as well as by weekly and monthly pain.

There was some apparent relationship between pain and the frequency of symptoms in the various supermarkets :

- Lower Back: overall 27% of all respondents reported daily trouble, but the figures were 9% for Kenilworth and 6% for Constantia and 3% each for Bellville and Waterfront.
- Shoulders: 25% of respondents reported daily trouble, but it was 10% for Kenilworth and 5% for Constantia. The other supermarkets reported 3% and lower for shoulder pain.
- Neck: 6% of all respondents reported neck pain, but it was 4% for Constantia
- Upper Back: 9% of all respondents reported pain, but it was 4% for Bellville and 3% for Constantia

4.4.3. Percentage of cashiers who had treatment

37.75% had had no treatment and 57.14% had had some sort of treatment for musculoskeletal pain. No significant relationship was found between treatment and satisfaction

4.4.4. Reported causes of musculoskeletal pain

Table 14 Reported causes (%) of musculoskeletal pain from cashiers in the various stores (n = 98)

Causes	T/V	G/W	E/R	B/V	W/F	S/P	K/W	Const
Scanning	53	60	71	70	100	100	81	75
Standing	61	20	0	10	12.5	0	4	5
Stress	15	0	28	20	0	0	0	20
Pregnancy	0	10	00	0	0	0	0	5
Sitting	7	10	0	10	0	50	31	15
The Chair	0	10	0	10	0	0	13.6	30
Lifting	0	20	42	30	12.5	0	27	5
Twisting	0	0	0	10	62.5	0	22	5
Bending	0	0	0	0	0	0	0	5
Packing	0	40	0	20	0	0	0	5

Key: Same as Table 12

Table 14 was able to show the subjective opinions of the cashiers as to the causes of their pain. Scanning was perceived by the cashiers to be the main cause of upper extremity pain. The variation in the percentage reporting scanning, or for that matter any of the other causes, as the main causal factor for pain may be attributed to differences between stores on variables, amongst them: high emotional stress levels (dealt with in another section), differences in anthropometrical measurements, dissatisfaction, differing checkout designs in each of the supermarkets and organisational management.

The questionnaire did not presuppose that pain was attributable to work, but rather asked for the cashiers' opinion as to the cause(s) of their pain. Cashiers were not given a list to choose from and could select more than one cause. For the four main body areas

cashiers indicated whether they attributed their pain to any of a number of factors. The factors included as causes for pain are only those that were reported by the cashiers.

Table 15 Attribution (%) of causes of musculoskeletal pain (n=98)

	Sca n	Stand	Stres	Preg	Sit	Chair	Lift	Twist	Bend	Pack
Nec	8		5			1			2	1
Shoul	45		2		1		4	2		4
LB	5	5	1	1	11	12	6		6	1
UB	9	2	1		1	1			2	

Key: Nec = Neck; Shoul = Shoulder; LB = Lower Back; UB = Upper Back; Scan = Scanning; Stand= Standing; Stres= Stress; Preg = Pregnancy; Sit = Sitting; Chair = Chair; Lift = Lifting; Twist = Twisting; Bend = Bending; Pack = Packing

The table shows a notably higher percentage of cashiers who reported that scanning caused pain in the shoulder area. Upper back and neck pain was reported to be affected by scanning. Lower back pain was reported to be most affected by the sitting and the chair in use, although scanning, standing, lifting and twisting during the task cannot be ignored. It is possible that all these causes could together be a causal factor.

4.4.5. Subjective estimates of days lost due to musculoskeletal pain

The actual days absent were obtained from records kept by the company and these were compared to subjective estimates of days lost. The cashiers gave an estimate of how many days they thought they were absent in 1997 for a specific musculoskeletal pain. Table 16 shows the percentage of actual days lost as a result of musculoskeletal pain as a proportion of the total days absent for 1997 in each supermarket.

Table 16 Percentage of total days lost in a particular supermarket attributable to musculoskeletal pain (n = 98)

Supermarkets	% days lost
Constantia	60%
Waterfront	34%
Kenilworth	26%
Bellville	18%
Sea Point	6%
Goodwood	20%
Tygervalley	34%
Eerste Rivier	43%

4.5. Dimensional Analysis

Successful ergonomic design depends on achieving a good fit between the dimensions of workspaces and their users. The variability in the size of the different users will impose constraints on the design. Knowledge of the body dimensions of users should help to specify physical dimensions and ranges of adjustability for the user population.

Although anthropometrical data do exist for some populations, there are large areas where no data exists. Furthermore, there are many large populations (as in South Africa) in which the variation within the population itself is larger than the variation between the population and populations of other counties (Shanavaz,1991). It is for this reason that use is often made (and will be made in this study) of the RASH (Rapid Anthropometrics Scaled for Height) technique, in order to specify physical dimensions and ranges of adjustability for the checkout operating systems (Chapanis, 1975). Chapanis concluded that a sizable proportion of variations amongst human populations in size of the body and its parts follow a regular pattern. His suggested

solutions to inter- and intrapopulation differences include minor changes in the positioning of the individual relative to the controls that he or she operates; a rational system of sizing; adjustability of equipment; and reliance on the adaptability of individuals. He advocated a radical rethinking of complex problems, which would avoid the 'economically unsatisfactory' solution of individual design for each population.

4.5.1. Constraints on Design of the Checkout System

Decisions about how the task should be designed were made after considering the postures adopted during the various stages of the cycle of scanning and packing goods, responses to the various questions from the questionnaire and anthropometrical dimensions.

4.5.2. Calculating Anthropometrical Dimensions

The RASH (Rapid Anthropometrics Scaled for Height) technique (Pheasant, 1986) was used to specify physical dimensions and ranges of adjustability for the design of the checkout system.

Dimensions to be calculated:

1. Sitting elbow height
2. Buttock-popliteal length
3. Popliteal height
4. Verticle grip reach (sitting)
5. Forward grip reach
6. Hip width
7. Elbow breadth
8. Thigh clearance

Dimensions measured:

1. Stature
2. Standing elbow height
3. Verticle grip reach
4. Standing hip height
5. Abdominal girth

This method required the knowledge of the stature of people in the target population (i.e. the employees being designed for). A set of scaling factors (SF) derived from a reference population, was used in order to estimate the dimensions we need.

Once the author had selected the variables to be estimated from the reference population, the SF for the mean and standard deviations was calculated. The SF for the mean was then deducted by calculating the ratio between the mean of the variable in the reference population and the stature in the reference population. Similarly the SF for the standard deviation is the ratio between the standard deviation of the variable of interest and that of stature in the reference population.

To estimate the 5th percentile point of the variable, 1.64 standard deviations are subtracted from the mean. For the 95th percentile, 1.64 standard deviations are added.

Example 1

The author aimed to specify dimensions for a chair that would be comfortable and prevent awkward postures in the cashiers of this particular chain of stores. The critical dimensions were seat depth, seat height and seat width. The dimensions that were needed were popliteal height, buttock-popliteal length and hip breadth from our target population. The dimensions that were collected from the sample population included: stature, standing hip height, standing elbow height and grip reach.

Data for females from the Swedish population were used as the reference population. This population was chosen because the standard deviations that were calculated for the dimensions appeared most similar those of the sample cashier population. Figure 9 (below) presents the standard deviations of the sample and of the Swedish female population.

Figure 9 Standard deviations of the referent and sample population

Population	Stature	SEH	SHH	R
Cashiers	0.044	0.07	0.061	0.092
Swedish	0.037	0.07	0.062	0.036

KEY: SEH= Standing elbow height; SHH= Standing hip height

R = Grip reach.

Example: Poplital Height

The SF for mean popliteal height is the ratio of popliteal height to stature. These are obtained using the Swedish female data:

Mean Popliteal Height = 400mm, Mean Stature = 1640 mm

Std dev = 29 mm, Std dev = 62 mm

Thus, the SF for the mean:

$$\begin{aligned} \text{SF (mean)} &= 400/1640 \\ &= 0.243 \end{aligned}$$

and the SF for the Standard Deviation (SD):

$$\begin{aligned} \text{SF(sd)} &= 29/62 \\ &= 0.467 \end{aligned}$$

The mean and SD for our target population, for stature, are 1593 mm and 73 mm respectively. So to obtain estimates for popliteal height in the target population we multiply our target population stature data by the scaling factors.

$$\text{Mean Popliteal Height (target population)} = 1593 \times 0.243 = 387.09 \text{ mm}$$

Standard deviation of Popliteal Height (target) = $73 \times 0.467 = 34.09$ mm

Popliteal Height puts constraints on the seat height as it has to be low enough for short people to sit and rest both feet firmly on the floor, or on a footrest.

We know already that 95% of the cashiers will be taller than 1.64 standard deviations subtracted from the mean. In other words 95% of the cashiers at Pick and Pay will have popliteal heights greater than

$$387.09 - 1.64(34.09) \text{ mm} = 331.09 \text{ mm}$$

This is used to specify the maximum dimension for the height of the chair, allowing 20 mm for shoes. So the bench must be no lower than

$331.09 + 20 = 351.18$ mm, which will allow 95% of cashiers to reach the floor with their feet. A footrest or the base of the checkout would serve to support the 5 percent of cashiers that are too short.

4.5.3. Design Dimensions

Given the dimensions for grip reach, standing hip and elbow height and stature we are able to work out the critical specifications for the following dimensions:

Table 17 Mean specifications

Dimensions in mm	Mean	SD	5th % ile	95th % ile
Sitting Elbow Height	208.6	36.5	148.7	268.4
Thigh Clearance	149.7	18.8	118.8	180.5
Buttock-Popliteal Length	469.93	38.8	406.3	533.56
Buttock- Knee Length	567	41	499.7	634.5
Hip Breadth	732.7	44.67	659.5	806
Popliteal Height	387	34	331	442.8
Forward Grip Reach	692.9	36.5	633	752.8
Grip Reach	606	64	501	710.9
Standing Hip Height	968	62	866	1069.6
Standing Elbow Height	1000	69	886.8	1113
Stature	1593	73	1473	1712.7

Depth of the chairs should be no longer than Buttock-Popliteal Length of the 5th percentile cashier, which is 406 mm. This will ensure that 95% of the cashiers are able to sit correctly with their backs against the lumbar support and it will ensure that the front lip of the seat does not cut into the posterior thigh thereby cutting the blood supply.

The width of the chairs should be able to accommodate the broadest hip breadth present in the cashier population. 95% of the hip breadth measurements of the cashiers fall at or below 806 mm.

The maximum sitting chair height can be derived using the dimension of the 5th percentile popliteal height. Thus 95% of the cashiers would be able to reach the floor with their feet if the chair height was not higher than 331 mm. Allowing 20 mm for ladies' shoes with heels, this would become 351 mm.

Armrest Height is derived from the sitting elbow heights of the cashiers. The armrests should be adjustable between 148.7 mm and 268mm, so as to accommodate 90% of the

cashiers. A note of caution is that if the armrests are too high the cashiers may have problems moving the chair in under the work surface.

Grandjean (1981) has recommended that the best level for performing manipulative tasks of moderate force and precision be between 50 and 100mm below the height of the elbow. The work surface height suggested is that of the average cashiers standing elbow (1 000 mm) height from which is subtracted the 50 and 100 mm respectively. Standing work surface height in this case should thus be between 900 mm and 950 mm for the average cashier.

To make the same work surface able to be used optimally by standing and sitting cashiers is a good option in order to avoid distractions that may occur due to discomfort (Bridger, 1995). Discomfort due to long periods of standing could occur due to static loading of ligaments, compression of soft tissue and venous pooling of blood, whilst sitting may bring about discomfort due to factors such as static loading of the ligaments, numbness in the buttocks, or static contraction of back muscles. Bridger (1995) states that 'postural fixity' should be avoided at a workstation and a workstation should be designed to accommodate various postures. This would necessitate the adjustment of the chair height to a maximum of 831.12 mm (950 mm – 5th % ile thigh clearance) and provision of a footstool, adjustable between 276.7 mm to 326.7 mm (900 mm – 95th% ile thigh clearance – 95th% ile popliteal height) for the shorter female employees.

It is recommended that the 'forward legroom' (Pheasant, 1986) not be shorter than the 95th percentile buttock-knee length of the cashiers, which is 634.5mm. The 'vertical legroom' (Pheasant, 1986) under the work surface should be no less than:

95% ile popliteal height + adjustable height of the footstool +95% thigh clearance = 900 –950 mm.

The 5th percentile Forward Grip Reach denotes the maximum distance that the shortest person is able to reach when leaning forward. In other words the above dimensions

suggest that the design of the workstation and inflow of goods on the belt should not allow the cashier to reach forward to grasp an object or perform a function more than 633.09mm away from her body.

4.5.4. Suggested versus Actual Dimensions

Table 18 presents the dimensions determined by the above calculations and the actual dimensions as they occur in the various supermarkets.

Table 18 Suggested and actual dimensions of the workstations in various stores

Dimensions (mm)	Suggested	ER	SP	W/F	Const
Work Height	866.3	840	810	860	760
Floor to Work surface	829.3	720	750	740	680
Work Height at Till	866.3	1100	1010	930	1080
Leg space below Till	829.3	430	640	490	
Built in Footrest	206	220		230	
Dist to Till Slip	633	520	560	490	480
Depth of Legroom	634.5	260	340	260	350
Depth of Work surface	501	590	600	290	600
Chair depth	406	350	350	350	420
Chair Width	806	380	380	380	450
		320			
Chair Height (sitting)	351.3				500
Chair Height (standing)	557.3	540	540-660	540-660	500

Dimensions (mm)	K/W	G/W	T/V	B/V
Work Height	850	800	920	820
Floor to Work surface	720	670	895	680
Work Height at Till	1450	1450	1010	1040
Leg space below Till			440	
Built in Footrest	220	190	180	190
Dist to Till Slip	500	520	490	540
Depth of Legroom	260	530	280	500
Depth of Work surface	590	540	610	540
Chair depth	360	300	320	360
Chair Width		300	320	360
Chair Height (sitting)				
Chair Height (standing)	620	730	690	650

A comparison was made between the suggested dimensional measurements and the actual measurements at each supermarket. Table 18 shows that there are large differences in some of the dimensions of the various checkouts. The data show a tendency for checkouts with a high work surface to lack the needed leg space under the work surface. Cashiers were forced to sit a 'buttock to knee' length away from the work surface and still reach over to scan goods. The leg space under the till was half of what was required in order to be useful to the cashier. In order for the cashier to move closer to the till or work surface, she needed to shift to the front point of her chair away from the backrest, with the knees pointing downwards. The footrests that were available were built in, which did not allow the cashier flexibility in changing her sitting position. Although all the till lengths were well within the recommended dimensions, when one considers that the buttock-knee length still needs to be incorporated into this equation, the result is far above the recommended grip reach length when detaching the customer slip from the back of the till.

4.6. Usability of the work station

Table 19 The percentage of cashiers who reported usability problems with the workstation

Problems	Total	T/V	G/W	E/R	B/V	S/P	W/F	Con	K/W
Knobs and Switches	2							5	5
Seating	66	53	70	42	60	75	50	80	86
Work surface too high	6	15				25	12.5	5	5
Work surface too low	7	7			10		12.5	55	50
Pushing/Pulling loads	25	38	40		20	25	37.5	25	22
Lifting Loads	23	46	60	42	40			10	9
*Inad leg/foot room	8	15	10		10			10	9
*Inad feet support	20	38				25	25	30	27
No foot rail	19	38	10	14		50		25	22
Not get legs under work surface	12						25	5	5

* Inad = inadequate

The percentages of problems were generally higher for chairs than for the checkouts themselves. Factors cited as problems were related to space constraints and the physical placement of scanners, tills etc.

On observation, chairs were extensively used and subject to considerable wear and tear. The chairs were found to be in poor condition, except for the newly acquired chairs in C/S. Seats in the other stores were not height adjustable; of those that were, the mechanisms were difficult to use. This was either because adjustments could not be made whilst seated, or the mechanism was defective, very tight or awkward. In order to benefit from the use of a backrest, cashiers needed to be able to sit well back on the seat. This was found to be generally incompatible with checkout designs and task demands,

which required the body to be inclined forwards. The responses supported the objective ergonomic findings of the dimensions of the workstations.

4.6.1. Associations between usability and pain

Table 20 summarises the anthropometrical dimensions that were tested for an association between reported usability problems and musculoskeletal pain

Table 20 Potential problems and related dimensions

Potential Problem	Dimensions Tested
1. Pushing/Pulling loads	Grip reach, Stature, Weight
2. Inadequate legroom	Stature, Standing hip height, Weight
3. Low work surfaces	Stature, Standing elbow height
4. High work surfaces	Stature, Standing elbow height, Grip reach
5. Seat	Standing hip height; Time on the job Abdominal girth; Satisfaction
6. Problems with lifting of the loads	Stature, Time on Job, Age, Abdominal girth Shoulder pain, Reach, Satisfaction
7. Problems with lifting	Stature, Weight, Age, Time on the job,

The data were analysed as contingency tables to find the chi-squared value for the association between various types of pain and different usability problems reported in this study. See Table 21.

Table 21 Tests for associations between pain and usability problems**Pushing and Pulling**

	Chi-squared	p<	df
Lower Back Pain	29.8	0.001	1
Shoulder Pain	35	0.01	1

Seating

	Chi-squared	p<	df
Shoulder Pain	59.7	0.01	1
Lower Back Pain	68	0.01	1

Work surface too low

	Chi-squared	p<	df
Shoulder Pain	5.9	0.05	1
Lower Back Pain	7.4	0.01	1

Lifting of Loads to scan

	Chi-squared	p<	df
Shoulder Pain	17.4	0.01	1
Lower Back Pain	4.7	0.05	1

Inadequate Legroom

	Chi-squared	p<	df
Shoulder Pain	30.6	0.01	1

The data presented in the above table show that those cashiers who reported pain in certain body areas also indicated the corresponding usability problem.

4.6.2. Variables Associated with Pain

In this section the data were analysed in contingency tables in order to ascertain whether the pain that cashiers reported were randomly distributed across each relevant variable in the questionnaire, or not. If pain were associated with body size measurements or the

level of satisfaction, for instance, this could have important implications for the future design of checkout systems and organisational restructure in the various stores.

The anthropometrical dimensions were divided into two categories corresponding to the upper and lower measurements to comply with the constraints of the statistical procedure

Thoracic back pain:

- Cashiers who had Grip reach measurements shorter than 0.57m reported significantly more thoracic back pain (chi-square = 67.17, $p < 0.01$, $df = 1$).
- 23% of cashiers who experienced thoracic back pain weighed between 78kg-130kg, 46% weighed between 55kg-78kg, 22% between 44kg-55kg and 2.8% under 44kg (chi-square = 10.27, $p < 0.05$, $df = 2$)
- Cashiers who reported 'needing this job' and who were 'dissatisfied' overall were more likely to report thoracic back pain (chi-square = 3.22, $p < 0.10$, $df = 1$)

Lower Back Pain:

- Cashiers who were 'dissatisfied' and 'needed this job' were more likely to report Lower back pain (chi-square = 4.1, $p < 0.05$, $df = 1$).
- * Cashiers who attained over 15/40 on their musculoskeletal stress level test, showed a greater likelihood of reporting lower back pain (chi-square = 4.6, $p < 0.05$, $df = 1$)

Shoulder Pain:

- Cashiers taller than 1.54m tended to experience more shoulder pain (chi-square = 5.3, $p < 0.05$, $df = 1$)
- Cashiers who indicated that they were 'dissatisfied' and 'needed this job' showed a high likelihood of reporting shoulder pain (chi-square = 24.89, $p < 0.01$, $df = 1$)

Neck Pain:

- Cashiers taller than 1.54m tended to report more neck pain (chi-square = 7.39, $p < 0.01$, $df = 1$)
- Cashiers with Grip Reach longer than 0.57m had the tendency to report neck pain (chi-square=8.17, $p < 0.01$, $df = 1$)
- Cashiers who had emotional stress scores higher than 17/44 reported more neck pain (chi-square=4.13, $p < 0.05$, $df = 1$)

4.7. Correlations between variables

No significant (i.e. $p < 0.05$) relationship between the dependent variables, absenteeism and pain, was shown. However, these dependent variables were correlated significantly with various independent variables, which were in turn correlated significantly with one another. See Table 22 and 23 on the following page.

4.7.1. Anthropometrical Dimensions

Certain anthropometrical dimensions that depended on long bone growth and on the presence of soft tissue correlated highly with one another. See Tables 22 and 23. These findings support those of Botha (1997). However no significant correlation was found in this study between long bone and soft tissue dimensions e.g. stature and hip breadth. As expected stature correlated significantly with reach ($r = 0.53$), standing hip height ($r = 0.62$), weight ($r = 0.26$) and standing elbow height ($r = 0.65$). Standing elbow height correlated with reach ($r = 0.43$), weight ($r = 0.25$) and standing hip height ($r = 0.62$). Standing hip height correlated significantly with reach ($r=0.48$), and weight correlated with reach ($r = 0.26$) and abdominal girth ($r = 0.39$).

Table 22 Correlations between Emotional Stress and other Variables

Marked correlations are significant at $p < 0.05$

	?PAREAS	PAIN_RAT	ABSENT	CHLDU10	CONTROL?	PANIC	FRUSTRAT	ANGER	DESPARAT	HOPLESS	DEPRESSE	GUILTY	SELFCONS	RESTLESS	CRYEASIL	WEIGHT	REACH	ABDGIRTH	SHIPH	SELBOWH	STATURE	STEMOT	USAB	OFTEN	LAST
?PAREAS	1																								
PAIN_RAT	0.89	1																							
ABSENT	0.00	-0.05	1																						
CHLDU10	-0.13	-0.13	0.30	1																					
CONTROL?	0.16	0.18	-0.13	-0.13	1																				
PANIC	0.13	0.13	-0.12	0.09	0.37	1																			
FRUSTRAT	0.27	0.15	-0.19	-0.22	0.27	0.46	1																		
ANGER	0.22	0.25	-0.28	-0.36	0.43	0.18	0.40	1																	
DESPARAT	0.07	0.04	-0.17	-0.06	0.28	0.44	0.25	0.21	1																
HOPLESS	0.06	0.15	-0.12	-0.14	0.30	0.27	0.24	0.37	0.53	1															
DEPRESSE	0.17	0.16	-0.17	-0.04	0.11	0.32	0.39	0.25	0.25	0.21	1														
GUILTY	-0.13	-0.10	-0.17	-0.03	0.07	0.25	0.19	0.22	0.12	0.04	0.05	1													
SELFCONS	0.07	0.14	-0.15	-0.17	0.27	0.37	0.33	0.37	0.23	0.33	0.16	0.25	1												
RESTLESS	0.18	0.20	-0.18	-0.22	0.21	0.20	0.40	0.37	0.31	0.23	0.14	0.04	0.13	1											
CRYEASIL	0.12	0.11	0.01	0.04	0.30	0.35	0.28	0.18	0.28	0.28	0.21	0.21	0.16	0.18	1										
WEIGHT	0.13	0.05	0.04	0.18	0.17	0.01	0.02	-0.04	-0.02	-0.11	0.14	0.11	-0.05	-0.16	-0.09	1									
REACH	0.24	0.22	0.04	-0.02	0.13	0.18	-0.05	0.09	0.03	0.27	0.21	-0.08	0.09	0.09	-0.02	0.20	1								
ABDGIRTH	0.10	-0.01	-0.07	0.16	0.04	0.24	0.13	-0.09	0.15	-0.10	0.15	0.32	-0.18	0.05	0.09	0.59	-0.07	1							
SHIPH	0.09	0.21	0.07	0.03	-0.08	0.00	0.00	-0.07	0.08	0.13	-0.06	0.25	0.05	-0.05	-0.21	0.10	0.48	-0.06	1						
SELBOWH	0.21	0.18	-0.05	-0.06	0.09	0.20	0.15	0.07	0.16	0.14	0.06	0.18	0.05	0.17	-0.07	0.25	0.43	0.16	0.72	1					
STATURE	0.14	0.11	0.01	0.06	0.13	0.09	0.00	0.05	0.02	0.12	0.02	0.19	-0.07	0.07	-0.11	0.26	0.53	0.09	0.62	0.65	1				
STEMOT	0.02	-0.02	0.05	0.11	0.01	-0.03	-0.16	-0.05	-0.12	-0.14	-0.09	0.32	-0.25	0.07	-0.13	0.00	0.20	0.24	0.03	0.18	0.02	1			
USAB	0.50	0.48	0.06	-0.06	0.10	-0.08	0.02	0.13	0.01	0.13	0.35	-0.08	0.13	0.18	0.16	0.27	0.37	0.05	0.13	0.16	0.15	-0.06	1		
OFTEN	0.44	0.35	0.19	-0.19	0.10	0.14	0.01	0.03	0.20	-0.11	-0.12	0.01	-0.07	-0.03	0.12	0.04	0.01	0.08	-0.02	0.00	0.01	-0.12	0.16	1	
LAST	0.58	0.67	-0.04	-0.19	0.15	0.15	0.10	0.24	0.12	0.27	0.14	-0.15	0.09	0.20	0.09	-0.14	0.20	-0.14	0.00	0.15	0.14	-0.04	0.28	0.44	1

KEY: ?PAREAS = Number of pain areas; PAIN-RAT = Pain rate; ABSENT = Absent days; CHLDU10 = Children under 10 years; CONTROL? = Feeling out of control;

PANIC = feeling panic; FRUSTRAT = feeling frustrated; ANGER = feelings of anger; DESPARAT = feelings of desparation; HOPLESS = feelings of hopeless-

ness; DEPRESSE = feelings of depression; GUILTY = feelings of guilt; SELFCONS = feelings of self-consciousness; RESTLESS = feelings of restlessness;

CRYEASIL = feeling that one cries easily; WEIGHT = Weight Measurements; ABDGIRTH = Abdominal Girth Measurements; REACH = Forward Reach Measurements;

SHIPH = Standing Hip Height; SELBOWH = Standing Elbow Height; STATURE = Stature; STEMOT = Emotional Stress Levels;

Table 23 Correlations between the major variables in this study
 Marked correlations are significant at $p < .05$

	ABS	AGE	TIMON	PAIN?	AT	AW	CAUSE	DAYS�	PRAT	USAB	CH10	SATPAY
ABS	1											
AGE	0.15	1										
TIMON	-0.07	0.19	1									
PAIN?	-0.12	-0.06	-0.03	1								
AT	0.01	0.14	-0.16	-0.20	1							
AW	0.04	-0.13	-0.07	0.05	0.41	1						
CAUSE1	-0.03	-0.01	0.08	-0.03	0.11	0.04	1					
DAYS�	-0.02	-0.10	0.09	0.08	-0.29	0.03	0.01	1				
PAIN_R	0.01	-0.06	0.21	0.39	-0.19	0.17	0.14	0.37	1			
USAB	-0.07	-0.15	-0.13	0.17	0.04	0.09	-0.02	-0.03	0.22	1		
CH10	0.30	0.19	0.23	-0.06	0.01	0.03	-0.10	-0.19	-0.19	-0.08	1	
SATPAY	0.06	-0.08	0.12	0.03	-0.25	-0.07	0.22	0.27	0.10	-0.26	-0.02	1
JOBSECUR	-0.02	-0.08	-0.06	-0.10	-0.14	0.02	0.03	0.01	-0.11	-0.10	-0.03	0.47
COWORKER	-0.17	-0.15	-0.14	-0.02	-0.01	0.10	-0.10	0.13	0.13	0.08	-0.23	0.30
SUPER	-0.23	-0.09	-0.06	-0.09	-0.09	-0.02	0.12	0.16	0.11	0.03	-0.16	0.25
OVERL	0.05	-0.25	-0.05	0.20	-0.07	0.15	0.09	0.21	0.15	-0.04	-0.10	0.21
W	0.03	0.02	0.20	0.06	-0.09	0.11	0.08	0.03	0.03	-0.27	0.05	0.11
R	-0.03	-0.04	0.16	0.11	-0.29	-0.10	0.05	0.28	0.19	-0.19	0.04	0.35
ABDG	-0.05	0.07	0.16	0.10	-0.04	0.07	-0.05	-0.07	0.08	0.11	0.12	-0.06
SHIPH	0.00	-0.05	0.01	0.15	-0.25	-0.19	0.21	0.24	0.04	-0.18	0.05	0.21
SHE	-0.12	-0.04	-0.11	0.10	-0.29	-0.13	0.06	0.10	0.09	0.06	-0.01	0.09
ST	-0.02	-0.08	-0.07	0.33	-0.30	-0.06	0.19	0.14	0.15	-0.05	0.11	0.24
STEM	0.00	0.03	-0.12	-0.23	0.04	0.05	-0.08	-0.11	-0.02	0.19	0.13	-0.10
STMSK	0.07	0.05	-0.10	-0.18	0.10	0.13	-0.15	-0.06	-0.10	0.12	0.03	-0.14

KEY

ABS= Days absent; TIMON= the time spent on this job; PAIN ? = pain rate
 AT=injury at work; AW= injury away from work; CAUSE= number of causes reported
 DAYS�=dayslost due to muscلسkeletal pain/injury; PAIN_R= pain rating;USAB= number of usability problems; CH10= number of children under 10; SATPAY= satisfaction with the pay;
 JOBSECUR= feeling that their job is secure; COWORKER= satisfaction with co workers;
 SUPER= satisfaction with supervision; OVERL= overall satisfaction; W=weight; R=reach
 ABDG= abdominal girth; SHIPH= standing hip height; SEH=standing elbow height; ST= stature
 STEM= emotional stress; STMSK= musculoskeletal symptoms of stress

Table 23 cont.

	SUPER	OVERLW	R	ABDG	SHIPH	SHE	ST	STEM	STMSK	
JOBSECUR										
COWORKER										
SUPER	1									
OVERL	0.18	1								
W	0.04	0.43	1							
R	0.03	0.11	0.26	1						
ABDG	-0.13	0.17	0.39	-0.04	1					
SHIPH	-0.04	0.15	0.22	0.48	0.00	1				
SHE	-0.04	0.16	0.25	0.43	0.21	0.62	1			
ST	-0.02	0.13	0.26	0.53	0.16	0.72	0.64	1		
STEM	0.06	-0.10	-0.16	0.17	0.16	-0.04	0.12	0.00	1	
STMSK	0.06	0.06	0.04	0.08	-0.01	0.01	0.02	-0.01	0.59	1

Anthropometrical dimensions also correlated significantly with the following variables:

Usability

Usability in this study is defined as the parts of the workstation with which the cashiers reported problems. An increase in the reach dimensions of a cashier was shown to increase the usability of the workstation ($r = 0.37$), whilst an increase in body weight ($r = 0.27$) was shown to affect a decrease in usability of the workstation.

It is relevant to note that an increase in the age of the cashier led to a decrease in the overall satisfaction of the cashier ($r = -0.25$). This correlation could be understood in the light of the physical nature of the task of the cashier and the high prevalence of musculoskeletal injury. Furthermore, older women tend to increase in weight, which is shown above to decrease the usability of the workstation for the cashier.

Injuries at work

Contrary to reports elsewhere in this thesis that pain levels and areas of pain increase along with the increase in variables dependent on long bone growth, the data shows that it is also those cashiers with shorter reach ($r = -0.29$), standing hip height ($r = -0.25$), standing elbow height ($r = -0.29$) and stature ($r = -0.30$) who tend to report injuries at work.

Emotional Stress

Abdominal girth ($r = 0.24$) and feelings of guilt ($r = 0.32$) was related to emotional stress. The reach of the cashier's arms correlated significantly to feelings of hopelessness ($r = 0.27$) and to the level of pain reported by the cashier ($r = 0.22$). Hopelessness in turn correlated significantly with anger ($r = 0.37$). Anger was shown to correlate with a few other subsets of emotional stress, namely: frustration ($r = 0.40$), depression ($r = 0.25$), self-consciousness ($r = 0.37$) and restlessness ($r = 0.37$). Anger

was also seen to correlate with the number of pain areas ($r = 0.22$), the pain levels ($r=0.25$), absenteeism ($r = -0.28$) and the number of children under 10 years of age ($r = -0.36$). The subset of frustration appeared to show a direct correlation with the number of pain areas reported ($r = 0.27$).

The correlation between standing hip height and the subset guilty ($r = 0.25$) is significant although no satisfactory explanation could be found. The correlation between these two variables may have come about due to their association with other significantly correlated variables. See Figure 10

4.7.2. Absenteeism

Absenteeism, in general, did not correlate directly with job context dissatisfaction (pay, security, co-workers and supervisors), musculoskeletal stress, or pain as expected. However, evidence was found which showed an indirect association between musculoskeletal stress, pain and absenteeism bringing to light an associative network of variables from various classes that may work together to affect absenteeism.

Absenteeism, in general, was shown to increase with the number of children less than 10 years ($r = 0.36$) that each cashier had. Absenteeism was shown to increase as feeling of anger decreased ($r = -0.28$). It is possible that taking days off from work served to decrease the levels of anger, thus having a positive effect on the emotional stress of the cashier. The correlations seem to suggest that anger may be a reaction to stimuli in the work environment.

However, days lost specifically because of musculoskeletal injuries were shown to be positively associated with an increase in standing hip height ($r = 0.24$) and reach ($r = 0.28$). The pain levels experienced by the cashier ($r = 0.37$) were shown to influence the cashier to make the decision to take off work.

It is interesting that cashiers who indicated that they were satisfied with their pay ($r = 0.27$) tended to take more time off work for musculoskeletal injuries. Although this does not seem to make sense from this correlation, it is possible to understand why this would happen if one considers the point that Mets (1994) made that workers who are secure in their job tend to take leave more often. This point is supported by the data, which shows satisfaction with pay to be significantly correlated to the satisfaction with job security ($r = 0.47$), co-workers ($r = 0.30$) and supervisors ($r = 0.25$). The significant correlation between cashiers who are satisfied with their pay and reach ($r = 0.35$) and stature ($r = 0.24$) (shown in section 4.7.4 to be associated with pain) lends to the point that cashiers felt secure enough in their jobs to warrant taking leave because of musculoskeletal pain. The data showed that when satisfaction with pay decreased, injury at work increased ($r = -0.25$) and the more days leave that were taken led to less injuries being reported at work ($r = -0.29$).

4.7.3. Musculoskeletal Stress

Musculoskeletal stress correlated significantly with emotional stress ($r = 0.59$). (See Table 22).

4.7.4. Musculoskeletal Pain

The level of pain reported by a cashier was shown to be significantly increased by the feeling of anger ($r = 0.25$). Smith and Rhodelwalt (1986) found that anger was a factor that increased the likelihood of an injury reoccurring in a subject. Correlations also showed that the average time that the pain lasted for the cashier corresponded with the level of pain reported by the cashier ($r = 0.67$). The level of pain reported was shown to be further affected by reach ($r = 0.22$), standing hip height ($r = 0.21$) and usability problems ($r = 0.48$).

Increased pain levels ($r = 0.39$) were shown to influence the number of pain areas, as well as increase levels of frustration ($r = 0.27$) and anger ($r = 0.22$), stature ($r = 0.33$).

University of Cape Town

5. Multiple Regression

5.1. Introduction

The relationship between the variables was analysed to find any significant relationships with absenteeism. The major conceptual limitation of the regression technique is that one ascertains only relationships. Underlying causal mechanisms are a matter of interpretation in the light of a theoretical model. However, the use of the multiple regression technique does allow the question to be answered “ what is the best predictor of...”

Not more than 12 possible predictor variables were inserted in the equation at a time (Statsoft, 1995), to avoid “overloading” the model statistically.

It was assumed that the relationships between variables were linear. Fortunately, the multiple regression procedure is not greatly affected by minor deviations from the assumption of linearity.

A test was run before each multiple regression equation to examine the distribution of the dependent variable across independent variables. An observation was considered an outlier if it fell outside the mean (three standard deviations). Outliers were removed from the data and the regression equation repeated until the best fit was achieved. For each equation, the ‘normal probability plot of residuals’ was examined for any indications of gross violation of the linear assumption.

Multiple Regression was performed with each variable and the significant relationships shown below.

5.2. Predictors of Musculoskeletal Stress

The Distribution of the Dependent Variable (Figure 10) and the Normal Probability Plot of Residuals (Figure 11) were normal and can be seen on the following page. Three of the four outliers that were removed had extremely high stress levels, the causes of which could not be ascertained from the questionnaire. The fourth outlier had not completed the stress level test.

Table 24 Multiple Regression Analysis of Musculoskeletal Stress

R= .77814551 R²= .60551044 Adjusted R²= .54110398
F(8,49)=9.4014 p<.00000 Std.Error of estimate: 3.9356

	BETA	St. Err. of BETA	t(49)	p-level
Intercept			1.2	0.24
SATISF	-0.19	0.11	-1.69	0.1
PE_STRES	0.07	0.1	0.73	0.47
AGE	0.05	0.1	0.48	0.63
TIMONJOB	-0.09	0.1	-0.9	0.37
P_RATING	0.14	0.11	1.32	0.19
CHLDU10	0.19	0.1	2	0.05
STEMOT	0.74	0.09	8.06	0
USAB	-0.01	0.1	-0.11	0.91

Predictors are significant where $p < 0.05$.

Key: SATISF = satisfaction; PE STRES = people stress; AGE = age; TIMONJOB = time on the job; P RATING = pain rating; CHLDU10 = children under 10y; STEMOT = emotional stress; USAB = usability

The above model was able to predict 60% of the variability of Musculoskeletal Stress. EMOTIONAL STRESS ($Beta = 0.73$, $p = 0.00$) had the biggest relative contribution of the independent variables to predict Musculoskeletal Stress. CHILDREN UNDER 10 years ($Beta = 0.19$; $p = 0.05$) was shown to contribute to reports of musculoskeletal stress.

5.3. Predictors of pain

The Distribution of the Dependent Variable (Figure12) and the Normal Probability Plot of Residuals (Figure 13) were normal and can be seen on the following page. Two of the three outliers that were removed from the model showed high levels of stress related to the people they worked with and the third cashiers reported high levels of emotional and musculoskeletal stress. All three reported high levels of pain and high absenteeism.

Table 25 Multiple Regression Analysis of Musculoskeletal Pain

R= .75642183 R²= .57217398 Adjusted R²= .46093922
F(13,50)=5.1438 p<.00001 Std.Error of estimate: 3.1142

	BETA	St. Err. of BETA	t(50)	p-level
Intercept			0.75	0.46
SATISF	0.1	0.12	0.84	0.41
PE_STRES	-0.07	0.12	-0.56	0.57
ABSENT	-0.02	0.1	-0.23	0.82
CHLDU10	0.02	0.1	0.25	0.81
WEIGHT	-0.07	0.13	-0.54	0.59
REACH	-0.07	0.13	-0.54	0.59
ABDGIRTH	0.11	0.14	0.79	0.43
SHIPH	0.26	0.17	1.56	0.13
SELBOWH	-0.01	0.14	-0.07	0.95
STATURE	-0.23	0.16	-1.43	0.16
STMSK	-0.06	0.1	-0.59	0.56
USAB	0.32	0.11	2.84	0.01

Predictors are significant where $p < 0.05$

Key: SATISF = Satisfaction; PE STRES = People Stress; ABSENT = Absenteeism; CHLDU10 = children under 10y; WEIGHT = weight; REACH = Reach; ABDGIRTH = Abdominal Girth; SHIPH = Standing Hip Height; SELBOWH = Standing Elbow Height; STATURE = Stature; STMSK = Musculoskeletal Stress; USAB = Usability; LAST = Amount of days/months/years that pain lasts

Figure 10

Distribution of Dependent Variable Musculoskeletal Stress

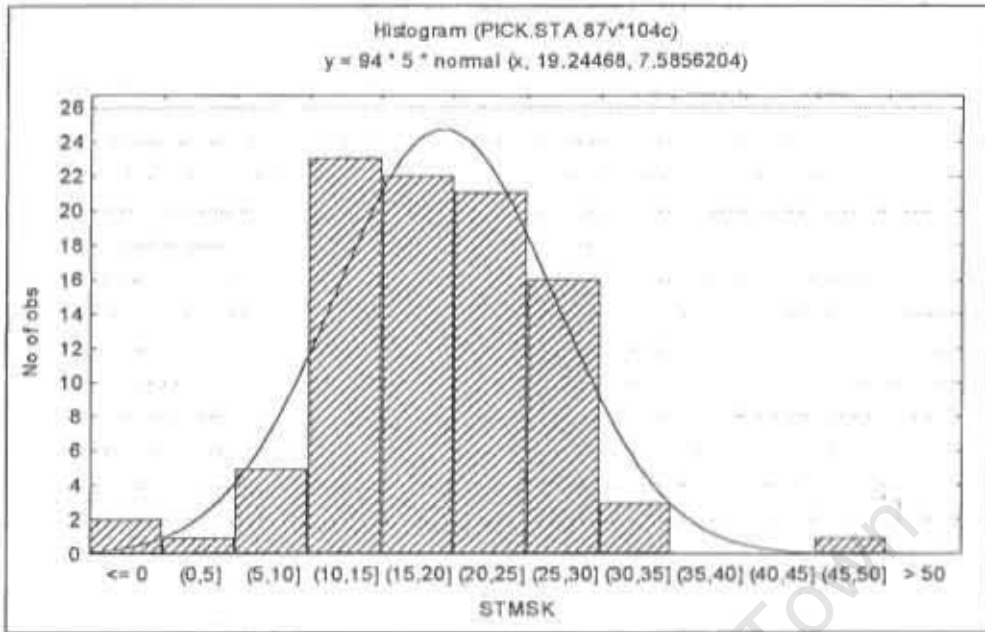


Figure 11

Normal Probability Plot of Residuals

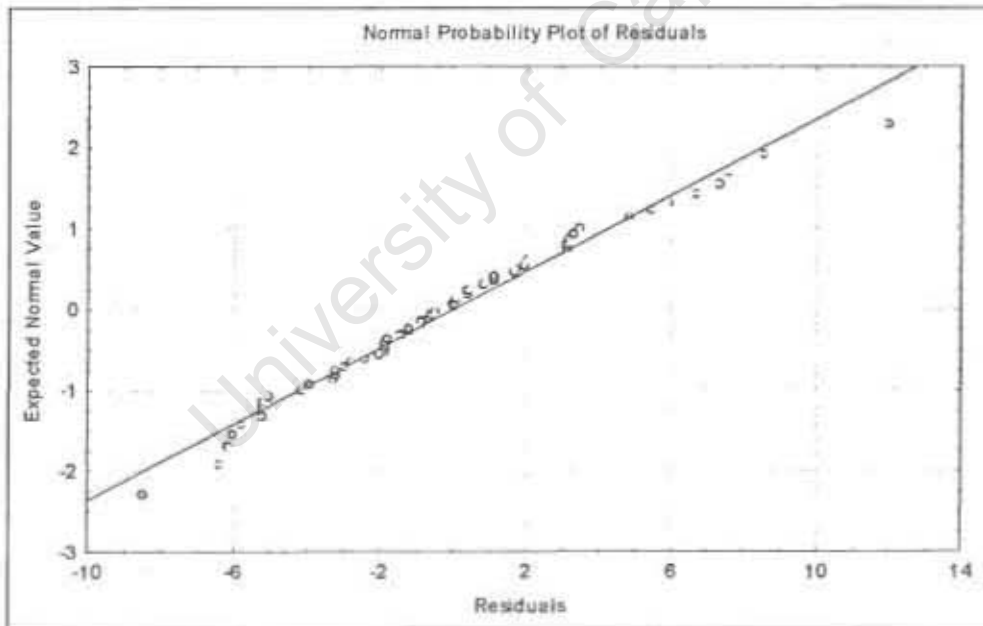


Figure 12

Distribution of Dependent Variable Pain

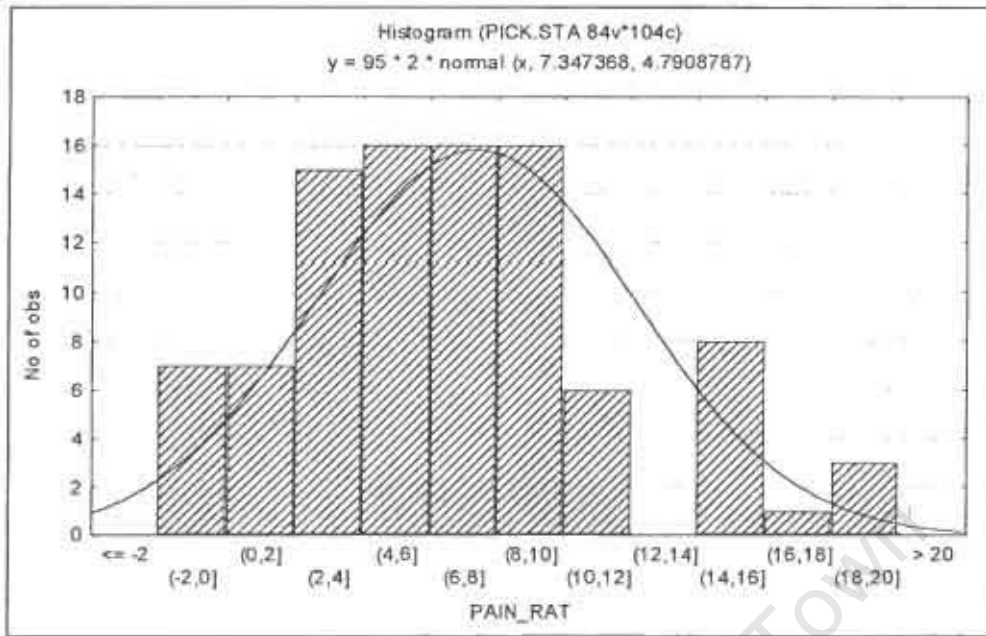


Figure 13

Normal Probability Plot of Residuals

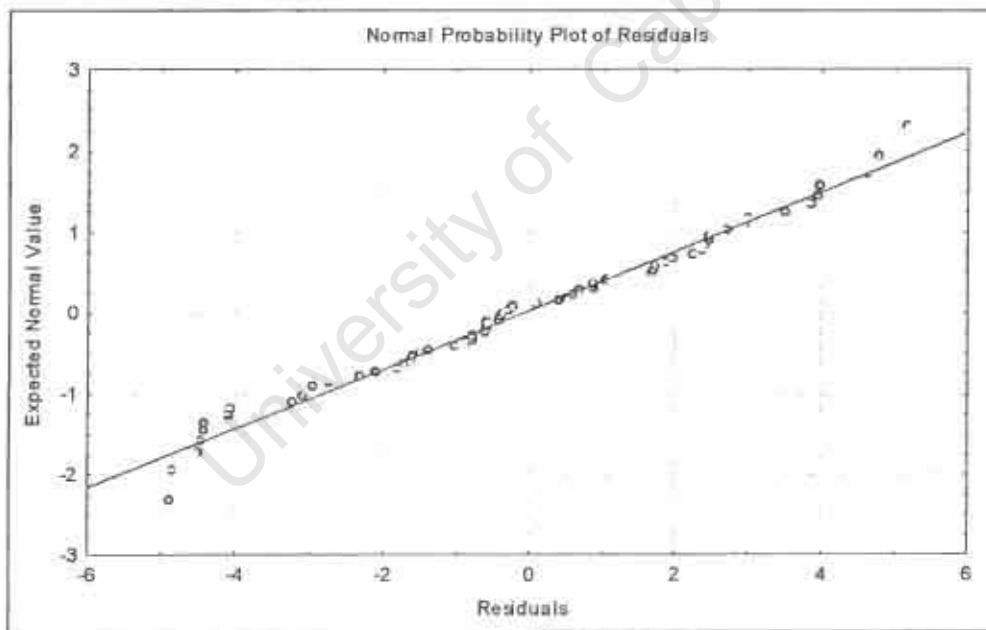


Table 25 was able to show that the variable USAB ($Beta = 0.31$, $p = 0.000$) was the significant contributor to musculoskeletal pain. In other words the more parts of the workstation that cashiers had problems with the more they reported musculoskeletal pain.

5.4. Predictors of Absenteeism

The Distribution of the Dependent Variable (Figure 14) and the Normal Probability Plot of Residuals (Figure 15) were normal and can be seen on the following page. All four outliers had absent days in excess of 1000 days, due to pregnancy.

Table 26 Multiple Regression Analysis of Absenteeism

R= .63818781 R²= .40728369 Adjusted R²= .26554718
F(11,46)=2.8735 p<.00593 Std. Error of estimate: 55.608

	BETA	St. Err. of BETA	t(46)	p-level
Intercpt			1.06	0.29
SATISF	0.27	0.14	1.92	0.06
AGE	0.2	0.13	1.57	0.12
CHLDU10	0.13	0.12	1.09	0.28
SIT_STIL	0.25	0.13	1.92	0.06
SELFCONS	0.31	0.13	2.47	0.02
WEIGHT	-0.31	0.18	-1.71	0.09
REACH	0.34	0.15	2.32	0.02
ABDGIRTH	0.23	0.17	1.32	0.19
STATURE	-0.35	0.14	-2.51	0.02
USAB	-0.06	0.14	-0.41	0.69
LAST	-0.05	0.14	-0.39	0.7

Predictors were significant where $p < 0.05$

Key: SATIS = satisfaction; AGE = Age; CHLDU10 = children under 10; SIT STIL = difficulty in sitting still; SELFCONS = self consciousness; WEIGHT = weight; REACH = reach; ABDGIRTH = abdominal girth; STATURE = stature; USAB = usability; LAST = the number of day/months/years that the pain lasted

Table 26 shows that a number of the independent variables were able to predict absenteeism. The variables SELFCONS ($Beta = 0.31$, $p = 0.017$), REACH ($Beta = 0.34$, $p = 0.02$) and STATURE ($Beta = -0.35$, $p = 0.02$) were calculated to be the three

Figure 14

Distribution of Dependent Variable Absenteeism

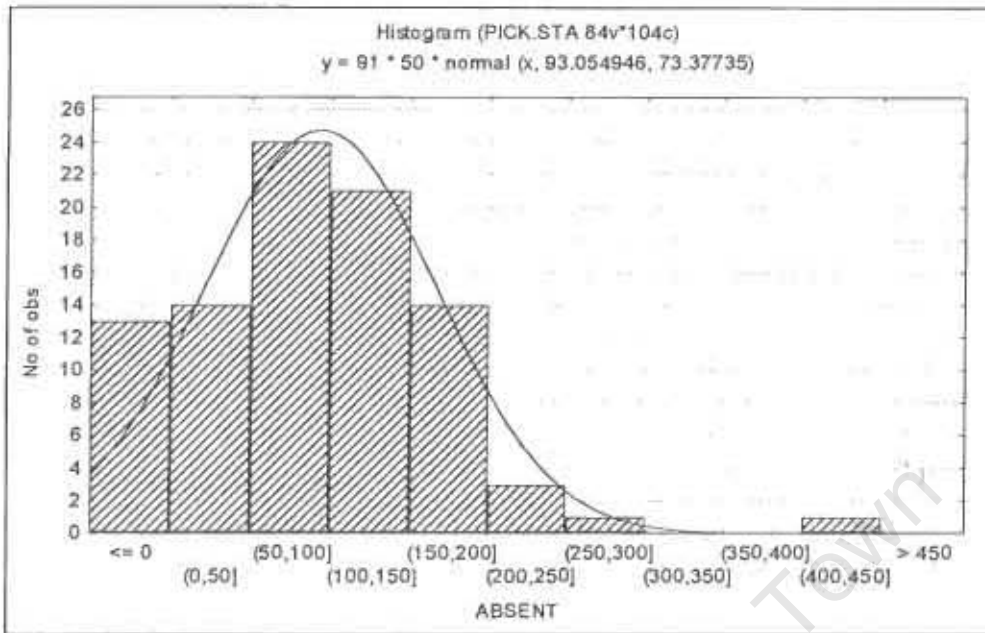
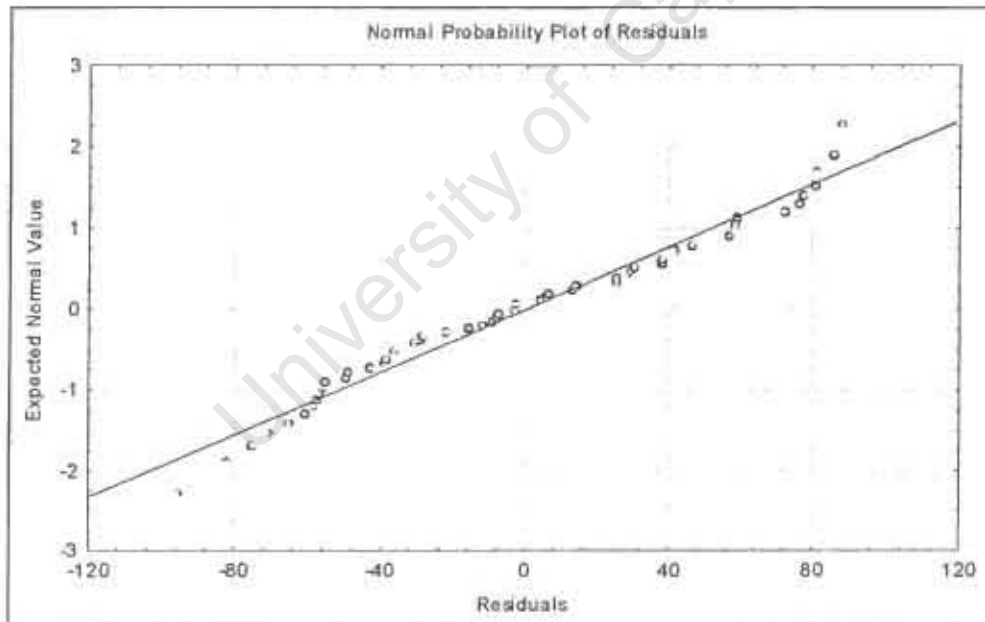


Figure 15

Normal Probability Plot of Residuals



significant predictors of absenteeism in this study. The regression coefficient for STATURE was negative indicating that shorter cashiers tended to be absent more often. Interestingly though, the variable REACH had a positive coefficient indicating that those cashiers who had a long grip reach also tended to be absent more often. This information appears to be contradictory because both Reach and Stature are dependent on long bone growth (Botha, 1997) and have a significant correlation ($r = 0.53$) with one another.

Univariate analysis showed that those cashiers who were taller than 1.54m reported more thoracic back pain (Chi-squared = 3.16, $df = 2$) than their shorter coworkers, whilst the shorter workers complained of inadequate foot support and reported lower back pain more frequently (chi-square = 7.4, $p < 0.01$). Both these causes may lead to musculoskeletal strain.

5.5. Predictors of Emotional Stress

The Distribution of the Dependent Variable (Figure 16) and the Normal Probability Plot of Residuals (Figure 17) were normal and can be seen on the following page. All three of the outliers reported high people stress with corresponding high emotional stress levels. Two of the outliers had abdominal girths in the fourth quartile (range 1 m and 1.99 m); the third had a height, which fell into the fourth quartile (range 1.64 m – 1.8 m).

Table 27 Multiple Regression Analysis of Emotional Stress

R= .80945093 R²= .65521081 Adjusted R²= .58084452
F(11,51)=8.8106 p<.00000 Std.Error of estimate: 4.1939

	BETA	St. Err. of BETA	t(51)	p-level
Intercpt			0.04	0.97
PAIN_RAT	0.08	0.12	0.67	0.51
PE_STRES	-0.01	0.1	-0.13	0.9
CHLDU10	0.04	0.09	0.48	0.63
WEIGHT	-0.45	0.13	-3.46	0
REACH	0.25	0.12	2.16	0.04
ABDGIRTH	0.58	0.12	4.82	0
SELBOWH	0.07	0.12	0.59	0.56
STATURE	-0.11	0.12	-0.94	0.35
STMSK	0.6	0.09	7.01	0
USAB	0.04	0.1	0.42	0.67
LAST	-0.17	0.12	-1.43	0.16

Predictors are significant where $p < 0.05$

Key: PAIN RAT = pain rate; PE STRES = people stress; CHLDU10 = children under 10y, WEIGHT = weight; REACH = reach; ABDGIRTH = abdominal girth; SELBOWH = standing elbow height; STATURE = stature; STMSK = musculoskeletal stress; USAB = usability problems; LAST = the days/months/years that the pain lasts.

Figure 16

Distribution of Dependent Variable Emotional Stress

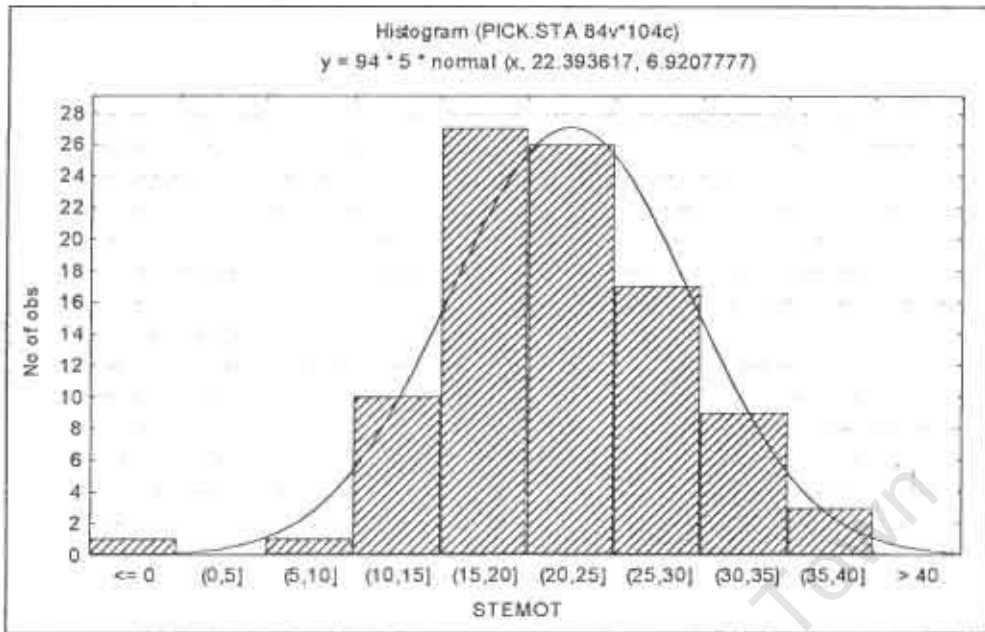
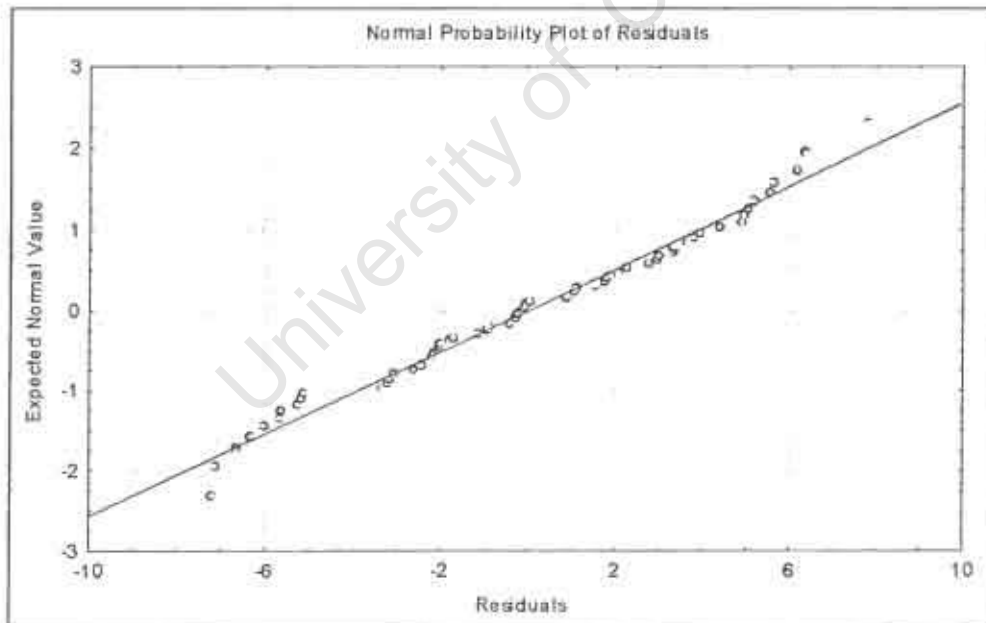


Figure 17

Normal Probability Plot of Residuals

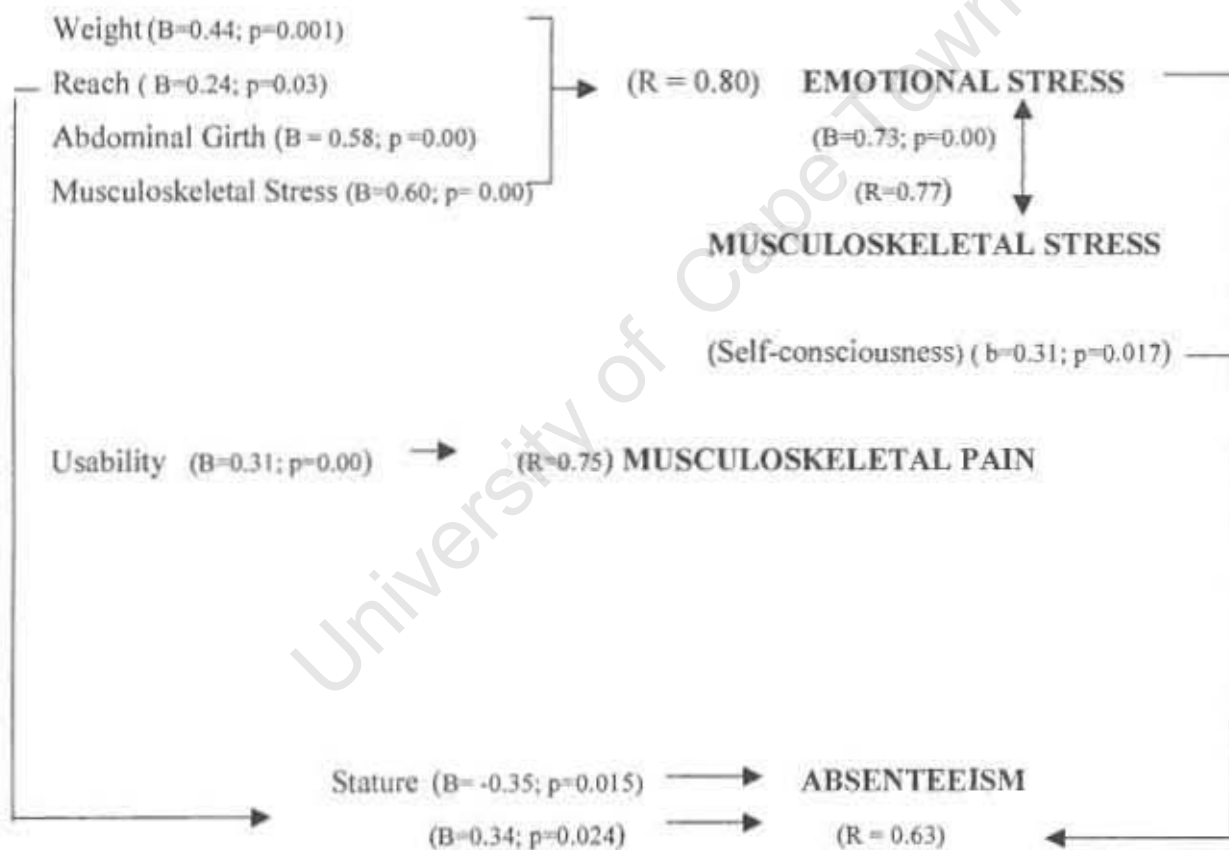


The above model in Table 27 shows that there were four significant predictors of Emotional Stress, STMSK ($Beta = -0.60$, $p = 0.000$), ABDGIRTH ($Beta = 0.58$, $P = 0.000$), WEIGHT ($Beta = -0.44$, $p = 0.001$) and REACH ($Beta = 0.24$, $p = 0.04$).

5.6. Summary of the Network of Relationships Between Variables

The results from the multiple regression equations support many of the associations derived from the correlation's and displayed in the flow-chart.

Figure 18 Network of Relationships between Variables



The above flowchart shows how anthropometric variables and emotional stress interact to cause musculoskeletal stress and pain and finally result in avoidable costs related to absenteeism.

6. Discussion

This study was able to show a how a network of associated variables in the work environment promoted absenteeism and musculoskeletal pain. The key variables shown in this study to affect absenteeism and musculoskeletal pain were workstation design and emotional stress.

A complex, nonlinear systems model is required to account fully for the relationship of these elements to worker health. According to researchers (Levi, 1972; European Foundation, 1995; Hawkins, 1987) cognitive, behavioral, emotional and physiological reactions influence the development of pathogenic mechanisms that increase the risk of morbidity and decrease perceived health status.

The combined effects of each factor may lead to psychosocially influenced disease or conditions such as cumulative trauma disorder. The models show a system with continuous feedback among the factors. Psychosocial stimuli arise from the social and emotional environments of the person. These stimuli based on personal, developmental and genetic characteristics of the person, which in turn create a stress response (Levi, 1972). In some cases the stress response lead to the precursors of the disease or to the disease itself.

A state of stress exists when an employee experiences a situation as threatening or as in this case painful and cannot make the necessary changes to reduce the pain. Cashiers in this study perceived that certain design aspects of the checkout system were the cause of the pain that they were experiencing. This was supported by the results in Table 21. Unfortunately they were not empowered to make the necessary changes themselves, nor were any changes made by management. In this case the changes would include the necessary alterations in design of the checkout system to alleviate the anthropometrical mismatch, or time-off to cope with emotional stress.

An environment that creates demands beyond a worker's coping abilities evokes a complex series of physical and emotional reactions. An increased secretion of epinephrine and norepinephrine is generated. Adrenocorticotrophic hormone is secreted by the pituitary gland, an important element in the body's immune response (Sanders, 1997). Cardiovascular risk factors have been shown to be affected by these neuroendocrine changes, but there is preliminary evidence suggesting that musculoskeletal systems are also influenced by the same process (Frankenhaeuser, 1991)

Coping skills are called into action when a person experiences injury or illness. According to Lazarus and Folkman (1984), coping allows a person to maintain a positive self-image, tolerate negative events, and maintain emotional equilibrium. This study was able to show how emotional stress was aggravated by anthropometrical factors (excess weight and abdominal girth, long or short long bone dimensions) that were precursors to musculoskeletal stress. Reach and weight have been significantly associated to other anthropometrical dimensions, such as stature, standing elbow height and standing hip height, which depend on long bone growth (Botha, 1997).

The above anthropometrical dimensions were shown to be strongly related to emotional stress (especially depression), which promoted musculoskeletal stress, which further aggravated emotional stress (specifically the subset self-consciousness). Emotional stress along with the anthropometrical factors dependent on long bone growth was shown to affect the outcome of absenteeism. The anthropometrical factors were also found to significantly contribute to usability problems at the checkout workstation. Usability problems, in turn, were shown to be related to the experience of musculoskeletal pain.

The type of coping style used depends on the personal characteristics of the individual, environmental factors such as availability of social support and the presence of life stressors and the individual's appraisal of the stressful situation (Parkes, 1986). Two primary ways of coping have been identified by investigators (European Foundation, 1995; Furnham, 1997; Hawkins, 1987): problem focused and emotion focused. Coping styles are then classified further into approach strategies and avoidance strategies.

Approach strategies include trying to identify and solve problems, seeking information and seeking social and emotional support. Avoidance strategies include denial, resigned acceptance, hostility and passivity. The sample in this study showed that cashiers tended to show symptoms of the avoidance strategy: 58% reported feelings of hopelessness once a month, 14% reported feelings of anger daily and 30% experienced anger once a week; 56% said they would take sick leave without going to see a doctor.

This study was able to support the findings of Leino and Magni (1993) who found that depression and distress symptoms predicted musculoskeletal morbidity of the neck, shoulders and lower back. The investigators did not find the reverse temporal sequence for depression, although the onset of musculoskeletal symptoms was associated with distress. Furthermore, many studies have identified hostility and anger to be the dominant emotions influencing the cognitive appraisals of pain sufferers. It has been shown that many patients inhibit their admission and expression of anger, because of the perceived social consequences of this emotion. This inhibited anger is believed to be a mediator of depression in persons with chronic pain. Anger, depressed, or hostile persons with painful musculoskeletal disorders are more likely to adopt maladaptive health habits and lifestyles that complicate treatment and prolong disability (Fernandez and Turk, 1995; Waddell, 1992).

Aggression or escape (expressed as increased absenteeism) are clearly counterproductive to acceptable or efficient working practice and whilst perhaps helping one individual to cope will in fact heighten the stress levels generally among colleagues. A direct action approach to reduce workplace stressors can be achieved by an ergonomic approach to the problem and that this, if successful, will obviate the need to resort to unhealthy coping mechanisms.

Conditions

The condition that was found to be the highest amongst the cashiers was that of headaches, a well-known musculoskeletal reaction to stress (Schwartz et al, 1997).

Schwartz et al. (1997) found that headaches had a significant impact on employee absenteeism, productivity and quality of life. Associations and relationships with trigger factors were however not identified in the study by Schwartz (1997). The study presented here was able to show a strong relationship between emotional stress and musculoskeletal stress of ($R = 0.77$) and it is therefore probable that emotional stress was a trigger for headaches amongst the cashiers.

The survey showed that 20% of the sample population smoked. Although smoking has been shown to be a confounding factor in work-related back disorders (Burdorf, 1997), this was not the case in this sample.

Children

The data showed the number of children per cashier was an influencing factor on absenteeism. There was a tendency for cashiers with three children or more to leave their children at home alone. Cashiers with two children or less preferred to leave their children with their mother or a friend. Absent days appeared highest for the cashiers who had only one child (8 days on average) and was also high for cashiers with two children. Cashiers with three or more children, were absent for only 4.3 days in the year on average.

Job Satisfaction

The study found an indirect relationship between job satisfaction and absenteeism. Evidence was found of associations between dissatisfaction and the report of pain in the upper, lower back and shoulder regions.

When asked if they were satisfied with their jobs 27% of the cashiers reported that they 'needed the job' and a further 34% said that they were merely 'content'. This study shows that there is an association between pain in various body areas and 'overall' dissatisfaction. 90% of cashiers who reported shoulder pain were dissatisfied with their

job (chi-square=5.3, $p<0.05$) and 72% who reported lower back pain were dissatisfied (chi-square=4.1, $p<0.05$). It is probable that the reporting of pain may be an excuse to take leave, once the maximum allowed days have been used. This study found that all cashiers, whether dissatisfied or satisfied, took the maximum allowed sick leave.

The question that needs to be answered is whether the pain causes the dissatisfaction or of the dissatisfaction is the cause of reports of musculoskeletal pain. It is not possible to distinguish between these two groups in this study. This is because this study has determined that there is a mismatch in the design of the workstations and therefore reports of musculoskeletal pain may be genuine and at the same time there is a psychological component to the problem which presents itself as dissatisfaction and which has as one of its symptoms reports of musculoskeletal pain.

Existing research largely assumes that job dissatisfaction represents the primary cause of absenteeism (Gibson, 1966). The probable existence of additional variables (both personal and organizational) may serve to moderate the satisfaction attendance relationship. Important situational constraints were not accounted for in this study but have been found in previous studies to influence the attitude-behavior relationship (Herman, 1973). Constraints such as poor health, family responsibilities and transportation problems may interfere with the decision to attend. Findings showed that 11% and 12% of the sample in this study reported family matters and 'personal matters' to be most stressful respectively.

Stress

Finding by Hedges (1973) showed that absenteeism rates were higher in jobs that were characterized by high levels of stress. Results from this study showed anthropometrical mismatches and musculoskeletal stress associated positively with emotional stress, which in turn associated positively with days absent. Emotional and musculoskeletal stress appeared to reinforce one another through a positive feedback mechanism. The results from the multiple regression analysis suggest that the mechanisms in this positive

feedback loop are the anthropometrical dimensions weight, reach and abdominal girth. Gibson (1966) suggested that level of stress and consequently dissatisfaction would probably cause employees to be less likely to want to come to work and thus present excuses of pain or illness (e.g. psychosomatic illness). In this study musculoskeletal stress was found to be significantly associated with the report of lower back pain (chi-square = 4.6, $p < 0.05$).

Musculoskeletal Pain

Problems with the usability of the workstations were reported to be the best predictors of the onset of musculoskeletal pain ($R = 0.75$). The causes reported for upper back and neck pain were spread thinly over the causes mentioned in section 4.4.4, however, a notable excess was seen in the percentage of cashiers who felt that scanning caused pain in the neck and upper back areas. Just under half of the cashiers felt that scanning was the cause of shoulder pain. Attribution of lower back pain was more or less spread over the possible causes, with excess in the percentage of cashiers who reported that their chairs and sitting for any amounts of time caused their lower back pain.

A day lost due to musculoskeletal pain/injury was shown to be associated with either larger than or shorter than average long bone growth, satisfaction (with pay, job security, co-workers and supervisors) as well as an overall dissatisfaction in the job. A subjective estimate by the cashiers, in the sample, of 946 days lost due to musculoskeletal injury in 1997 accounts for 82.9% of all absent days in 1997. The data suggests that a balance is necessary with regards to occupational and organizational variables in order to maintain an acceptable absenteeism rate. It is possible that the lack of sufficient or the right kind of channels through which the cashiers is able to seek help may lead to feelings of frustration and anger which has been shown in this study to increase the levels of pain reported by cashiers and increase the likelihood of the pain/injury reoccurring (Smith and Rhodelwalt, 1986).

Musculoskeletal complaints were common. Overall it was found that 22% of respondents reported pain in at least one of the 10 body areas during the previous year. 55% reported pain in more than one body area, with some 14% mentioning three or more areas. The largest proportion of recurrent problems occurred in the upper extremities, with shoulders and low back being most likely to be a daily complaint, followed by upper back and neck complaints. Most of the pain experienced in the ten body areas lasted from 1 –24 hours; the highest percentage of pain occurred in the shoulder, lower back, upper back and neck areas. Pain in the shoulder and lower back showed a tendency to persist over longer time periods than pain in the other areas. When asked 'how long the pain lasts', differences were found according to the design of checkout operated.

Causes of pain

Cashiers attributed most of the causes of pain to be a combination of scanning and standing, lifting, twisting, sitting and packing. By far the most predominant cause of musculoskeletal pain in each supermarket was scanning, which was also reported by approximately half of the sample to be the cause of shoulder pain. The range of causes reported by cashiers may be due to the differences in the design of the checkouts at various stores.

Checkout Design

The checkout designs evaluated represented a range covering older and more contemporary designs with the same scanner technology. Each starts with a produce delivery system, followed by a produce-checking method and then exit system. The delivery system was a conveyor belt; the price checking method was a cash register or a laser scanner (vertical or flatbed). The exit systems were chutes, which varied in angles across supermarkets. The cashier choose either to sit facing across the flow of goods or facing the delivery of flow, or the cashier choose to sit midway between the two positions so as to operate the till whilst scanning the goods.

Four mismatches were identified from the 'Actual versus Suggested Dimensions': examination of the dimensions in Table 18. These showed that the work surface height of five of the checkouts were too high and two were too low; all the checkouts except for C/S had too little leg space; and the tills were situated too high. Cashiers reported lifting problems at checkouts that were too low. Two usability problems were consistent across checkouts: scanning and using the chair.

Pain rates were the highest i.e. above 7/15, in supermarkets where there was a high average score of musculoskeletal stress, i.e. over 20/44. Emotional stress was seen to correspond to the higher levels of musculoskeletal stress; all supermarkets with high pain rates reported emotional stress levels above 20/40. These supermarkets also showed the highest incidence of pain lasting from 1 –24 hours in the shoulder, lower back and upper back areas.

Multivariate Analysis

Multivariate analysis enabled the evaluation of the individual combined influence of a number of variables. The study showed that a number of factors combined to contribute to the overall risk of absenteeism and musculoskeletal pain. Efforts have been made to provide a meaningful analysis of the data, but interpretation of the results does require that all significant variables be considered together. The portion of the regression equations not explained by the variables leaves room for improvement in the measurement of other possible contributors to absenteeism.

Significant and direct relationships were found between the variables reach, stature and absenteeism as well as emotional stress and absenteeism. These variables in turn exist in a positive feedback system that result in musculoskeletal pain and absenteeism thereby affecting both the employer and employee. The anthropometrical variables: weight, reach and abdominal girth as well as musculoskeletal stress were found to predict a large portion of emotional stress. Emotional stress in turn was found to predict an almost equally large portion of musculoskeletal stress. Musculoskeletal pain was best predicted

by usability problems with the workstation. This study has been able to show that these usability problems existed because of anthropometrical differences in body dimensions and the design of the workstations, and musculoskeletal pain was the result of the interactions between the resulting musculoskeletal stress and emotional stress. The number of problems reported was also seen to increase if the problem was not dealt with. This study was not able to determine whether any one of these variables caused musculoskeletal pain or whether it was their combined affect.

7. Conclusion

The study has succeeded in identifying an associative network of related and associated variables, which contribute to the decision to report pain as well as to absenteeism. Absenteeism is clearly counterproductive to acceptable or efficient working practice. While it helps one individual to cope it will heighten stress levels generally amongst coworkers. The variables that appeared to be the key to a large portion of absenteeism were the various anthropometrical dimensions. The emotional stress triggered to a large extent by anthropometrical dimensions and the ensuing musculoskeletal stress were shown to have significant relationships with musculoskeletal pain and absenteeism. The length of time that musculoskeletal pain persisted and the number of usability problems experienced with the workstation were shown to increase the intensity of the musculoskeletal pain. The necessity of dealing with such reports promptly in order to prevent the disability resulting from increased levels of pain to the employee and loss of productivity due to days absent, is self-evident.

Ergonomics is concerned with designing the workplace environment and the work organization to match the physical, physiological and behavioral limitations of the cashiers. At best, improvements can attempt to meet the needs of only a proportion of the cashiers because of human variability. In the calculations used the 95th percentile was aimed for in which 95% of the cashiers would find the solution acceptable; the remaining 5% would either select themselves out of the job, cope by adapting, or would in some way continue to suffer from stress as a result of the job. User trials, a technique not used in this study, to determine the suitability of a workstation by looking at how the workstation is actually used would be a valuable tool when considering a new workstation for the cashiers at this supermarket chain.

Lack of involvement in decision-making and poor relationships with colleagues can only be improved by attention to work organization. Worker morale needs to be lifted and channels to management opened to ensure that everyone has a personal involvement in

making decisions that affect them, and receives support and empathy in the case of reported injury/pain. To reduce stress levels every individual has to perceive a level of personal control and self-worth in the organization.

The results of this study agree with the conclusion of Hawkins (1987) that a 'direct action' approach is needed to reduce workplace (organizational) stressors and that this can be achieved by an ergonomic approach to the problem, which if successful, will obviate the need for employees to resort to unhealthy coping mechanisms.

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Appendix A

University of Cape Town

PAIN QUESTIONNAIRE

Name:-----Sex: Male 1

Work location:-----Age:----- Female 2

Shift:----- Hours per week:-----

*Type of scanner, if you are a cashier
Laser scanner 2
Old scanner 1

3.06 Male
95.9 (1000?)
1000000

* Time on this job: Less than 3 months 1
3 mths- 1 year 2
1 - 2 years 3
More 4

* Have you had any pain or discomfort, in any part of your body, during the past year that you believe to be related to your work?

NO 1
 YES 2

If YES, please proceed ...

Have you had an injury AT work? YES 1 NO 2

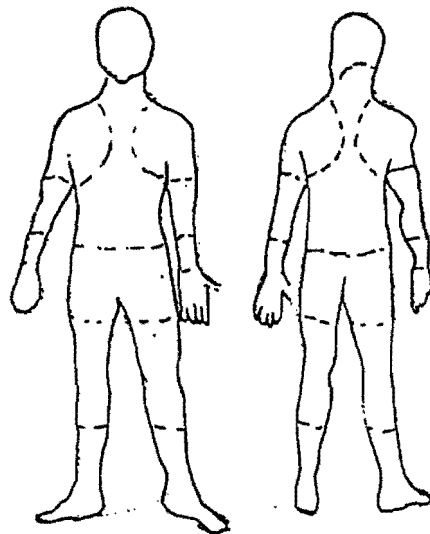
Have you had an injury AWAY from work? YES 1 NO 2

In which area did you have the INJURY?

Mark on the body:

Do you still have discomfort:

AT WORK 1
AT HOME 2
BOTH 3



- 1 NECK
- 2 SHOULDER
- 3 ARM
- 4 WRIST
- 5 FINGERS
- 6 UPPER BACK
- 7 LOW BACK
- 8 THIGH / KNEE
- 9 LOW / LEG
- 10 ANKLE / FOOT

Front

Back

* Do you play any sport or have any hobbies? No = 1 Yes = 2

* Do you have any sickness or conditions, that you know of e.g

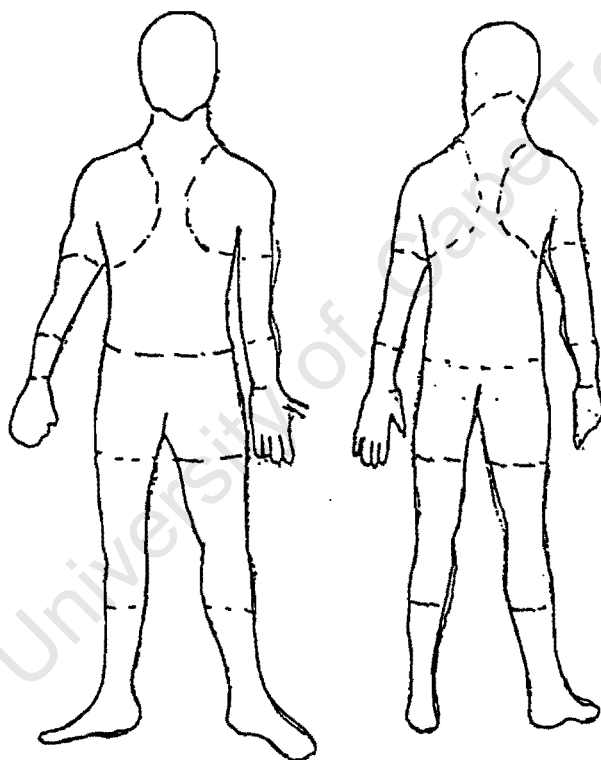
Diabetes/ "sugar" 1
 "Heart Problems" 2
 Smoker 3
 Pregnancy 4
 No sickness 5
 other: Headaches 6

<input type="checkbox"/>	1
<input type="checkbox"/>	2
<input type="checkbox"/>	3
<input type="checkbox"/>	4
<input type="checkbox"/>	5
<input type="checkbox"/>	6

Asma 7
 H Bp 8
 L Bp 9
 Arthritis 10
 Osteoporosis 11

} were these added afterward

IN WHICH AREA DO YOU GET PAIN THESE DAYS?



Front Back

WHAT KIND OF PAIN IS IT?

- 1 PAIN
- 2 NUMBNESS
- 3 TINGLING
- 4 ACHE
- 5 BURNING
- 6 SWELLING
- 7 STIFFNESS

How does the pain feel now?

- 1 Cannot feel it
- 2 Feel it on busy days
- 3 Pains at the end of the day
- 4 Pains when doing certain work
- 5 Pains all the time

Change

Please complete the section for each body part that bothers you:

① NECK ② SHOULDER ③ ARM ④ WRIST ⑤ FINGERS

How long does problem last?

?
 1 A <1hr
 2 B 1-24HRS
 3 C 1WK-1M
 4 D 1-6
 5 E >6M
 6 F <1HR

A	A	A	A	A
B	B	B	B	B
C	C	C	C	C
D	D	D	D	D
E	E	E	E	E
F	F	F	F	F

How often do you get this problem?

1.36 1.37 1.20 1.52

1 A constant	A	A	A	A
2 B daily	B	B	B	B
3 C 1 a week	C	C	C	C
4 D 1 a month	D	D	D	D
5 E 2-3 months	E	E	E	E
6 F >6 months	F	F	F	F

REASONS
 3 Stress
 4 Pregnancy
 5 Sitting
 6 Chair
 7 Lifting
 8 Scanning
 9 Standing

What do you think caused the problem?

Have you had medical treatment?

1 No 57.14% No No No No
 2 Yes 42.86% Yes Yes Yes Yes

Days lost due to this problem?

⑥ UPPER BACK ⑦ LOW BACK ⑧ THIGH/ KNEE ⑨ LOW/ LEG ⑩ ANKLE/ FOOT

8 Scanning
 9 Standing
 10 Packing

How long does problem last?

A <1hr	A	A	A	A
B 1-24HRS	B	B	B	B
C 1WK-1M	C	C	C	C
D 1-6	D	D	D	D
E >6M	E	E	E	E
F <1HR	F	F	F	F

How often do you get this problem?

A constant	A	A	A	A
B daily	B	B	B	B
C 1 a week	C	C	C	C
D 1 a month	D	D	D	D
E 2-3 months	E	E	E	E
F >6 months	F	F	F	F

What do you think caused the problem?

Have you had medical treatment?

No No No No No
 Yes Yes Yes Yes Yes

Days lost due to this problem?

How often were you absent in total last year?

STRESS QUESTIONNAIRE

PLEASE CIRCLE THE NUMBER.

<u>Symptoms</u>	<u>Never</u>	<u>Every few wks</u>	<u>Once a week</u>	<u>Daily</u>
Feeling tired	1	2	3	4
Headaches	1	2	3	4
Back/shoulder pain	1	2	3	4
Hands shaking	1	2	3	4
Alot of blinking	1	2	3	4
Nervous tics	1	2	3	4
Wrinkling forehead	1	2	3	4
Jaw ache	1	2	3	4
Pacing	1	2	3	4
Finger/foot tapping	1	2	3	4
Difficulty sitting still	1	2	3	4

TOTALS

45% = 50.35%

Feeling things are out of control	1	2	3	4
Panic	1	2	3	4
Frustration	1	2	3	4
Anger/Irritation	1	2	3	4
Feeling desparate	1	2	3	4
Feeling hopeless	1	2	3	4
Feeling depressed	1	2	3	4
Feeling guilty	1	2	3	4
Self- concious	1	2	3	4
Restless	1	2	3	4
Crying easily	1	2	3	4

TOTALS

WHICH OF THE FOLLOWING WOULD YOU USE AS A MEANS OF HELPING YOU COPE WITH STRESS AT WORK

- 1. Taking a sick leave (...) 1
- 2. Going to see a doctor (...) 2
- 3. Speaking to a friend (...) 3
- 4. Letting it blow over (...) 4
- 5. Speaking to the Nurse at work (...) 5

How much stress do the following cause you:

Not at all Slightly Moderately Very Extremely

① Customers					
② Co-workers					
③ Supervisors					
④ Management					
⑤ You					
⑥ Family					
⑦ Other.....					

Please rate how you feel about the following:

	Satisfied	Content	Dissatisfied
1. Satisfaction with pay	1	2	3
2. Satisfaction with job security	1	2	3
3. Satisfaction with co-workers	1	2	3
4. Satisfaction with supervisors	1	2	3

How satisfied are you in your present position as cashier?

Very Satisfied	Content	Need this Job	Very Dissatisfied
1	2	3	4

Do you have any children?.....

If so how many and how old?.....

Who takes care of them when you are at work?.....

- 1 = Mother
- 2 = friend
- 3 = Grache
- 4 = Alone