“You just keep walking into the pen to get your next sheep...”

An exploration of sheep shearer’s experiences and responses to heat in the sheep shearing industry.

Lucy Eleanor Cotterill

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Abstract

Heat in workplaces is a hot topic due to the projected increase in global temperatures from anthropogenic climate change with workers being recently recognised as a vulnerable group due to excess heat exposure. New Zealand provides a unique environment to study the impacts of heat in the workplace due to our dependence on physically active industries such as agriculture, forestry and the construction industry. These occupations are exposed to heat through different sources including the environment (outdoor workers), the physical nature (metabolic heat generation) of the work and are often paid by output. One seasonal, physical occupation, paid per output is the sheep shearing industry. This thesis is the first qualitative study of the industry internationally, it aims to explore sheep shearer’s experiences of heat and how they respond to it.

Purposive and snowball sampling techniques were used to gain a maximum variation sample (age, sex, geographical location and experience) of knowledgeable participants. Sixteen current and ex-shearers were interviewed face to face or over the phone, using an in-depth study guide about the experiences of heat in the workplace. The interviews were transcribed and analysed using a constructivist thematic analysis of the manifest and latent content.

The overall results suggest that sheep shearers will continue to work, and tolerate symptoms when exposed to excess heat, due to how they are remunerated for their work. All participants could give an example of tolerating symptoms of heat stress at work including; sweating, cramps and of the more extreme, fainting and heat exhaustion. Five themes were identified from the interviews as influencing workers experience of heat; ‘shearing culture’, ‘lack of control’, ‘we’ll be right’, ‘self regulation’ and a ‘want for change’. The identified themes influence how shearer’s currently respond to heat exposure at work, with their self regulation of behaviours and ‘we’ll be right’ attitude being at the centre of the tolerance of symptoms. However the results also suggest that current responses to heat are insufficient as there is a want for change from the younger generation of shearers. This want for change focused on a standardisation of wool sheds and their facilities, which implies a call for a more proactive response to heat. This proactive response to heat in the face of the projected increases in temperature due to climate change would be a way for the industry to sustain its current productivity and reduce health related consequence of heat. A standardisation of woolsheds would modify the variables that expose shearers to heat and reduce the need for a tolerance of heat within the industry. In conclusion, shearers will continue to work when exposed to heat due to how they are paid for their work. If there is no change in the industry to modify the working environment the projected future increases in temperature would pose potential health risks which in turn lead to a decrease in productivity.
Preface

‘An outsider’s perspective’

It is important for you as the reader to be introduced to the author of this research and understand who is writing this thesis for you to be able to appreciate certain decisions in the research process. In writing this section I set out my background, experiences and influences I may have had on the current research which adds to the creditability of it as outlined by Patton (1990).

I’m a 26 year old English born female that is privileged to call New Zealand home. Originally from the city (Manchester) in the UK, we moved as a family to New Zealand 12 years ago. Since moving here I have been lucky enough through friends to have had many experiences of rural life. I have never shorn a sheep in my life but have spent hours observing in the shearing shed out of sheer (excuse the pun) fascination for the occupation and the physicality of the work. This fascination has been very much shaped by my two undergraduate degrees in Exercise Prescription and Human Nutrition and the body’s ability to perform the job every day. When I refer to myself as an ‘outsider’ in this thesis, it refers to my position in relation to the study population used for the current research, and the overall sheep shearing industry. I have no experience of working within the industry myself, although I know many people who have previously and are currently working in the industry. As an ‘outsider’ I cannot fully relate to experiences of heat whilst shearing, but have experiences of my own of being exposed to heat whilst being physically active. This can allow a link to be found when experiences are being discussed during the interview. The ‘outsider’ has another advantage in that participants may explain their experiences in more detail. If I was part of the industry in some way there may have been a presumption that I understood things from their perspective. In this case they were able to share their experiences in more detail and be more complex in the explanations. It is important to be mindful to the ‘outsider’ position at which I approach the research from when reading the thesis as a whole but especially the methodology, methods and even more so the results and the discussion.
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Chapter One: Introduction

Heat in workplaces is a hot topic due to the projected increase in global temperatures from anthropogenic climate change and the health impacts of this hot weather have also become an increasingly popular topic. Although regional populations have some ability to adapt to variations in day to day climate through technological, behavioural, cultural and physiological responses extreme heat on a daily basis in locations with long hot seasons or heat waves in cooler locations can pose threats to this ability (McMichael, Woodruff, & Hales, 2006).

The effects of a global rise in temperature on working people and its impact can be exacerbated in certain circumstances due to occupation type, workplace design, physical activity or a combination of these. It is when working people cannot escape these increasing temperatures that they become vulnerable to the health impacts of excessive heat exposure. Therefore the likely effects of climate change for the vulnerable group of working people, include heat exhaustion (at work or everyday life), accidents related to heat exhaustion, clinical effects of heat on those with chronic diseases, heat stroke and even death (Hyatt, Lemke, & Kjellstrom, 2010).

Heat waves have the ability to settle in quickly leaving the human body struggling to adjust when put under this undue stress (McMichael et al., 2006). There are multiple studies that account for mortality increase with environmental temperature (Kovats & Bickler, 2012). An example is during the 2003 heat wave in Europe there was an excess of 30,000 deaths due to the being exposed to high temperatures (McMichael et al., 2006). There is compelling evidence of the health burden posed by heat and the impact this has on vulnerable groups (Kovats & Bickler, 2012). Vulnerable groups identified in the literature are; elderly and chronically ill (cardiovascular, respiratory and renal disease), young children, babies, people with limited mobility, people living in cities and those living in social deprivation (Kovats & Hajat, 2008). All of which have higher risk of heat related morbidity and mortality (Page, Hajat, Kovats, & Howard, 2012). Unfortunately there are gaps in the evidence about how the wider determinants of health are impacted by heat and the effect on heat related morbidity and mortality in these vulnerable populations. However this health burden has been projected to increase in those identified as vulnerable groups due to the projected increase in frequency and intensity of heat waves (Kovats & Bickler, 2012). Recent reviews have highlighted the need for health protection strategies around heat focussing on vulnerable populations to reduce the impact that climate change is to have on heat related mortality and morbidity rates (Kovats & Hajat, 2008; Page et al., 2012). The reviews indicate that the readily available knowledge about how to combat heat related health issues is sometimes contradictory and not well referenced, which in turn makes health protection strategies for vulnerable groups difficult. One group that has failed to be identified by such
reviews is workers and health protection strategies for the working population. However, research is becoming more popular within this vulnerable group stating an association between the health impacts of exposure to occupational heat and increases in temperature from projected changes in climate (Kjellstrom, Holmer, et al., 2009).

Recent studies have investigated exposure to high occupational temperatures and the impact this can have on workers' health and hourly productivity (Kjellstrom, Holmer, et al., 2009). It is clear from the research that an increased exposure to occupational heat can increase health risks, decrease productivity and in turn reduce economic output (Dash & Kjellstrom, 2011; Kjellstrom, Holmer, et al., 2009). This relationship is even more of a health burden in workplaces with high environmental temperatures and occupations with high physical demands, due to the inability to disperse the heat generated by muscular work, resulting in an overall rise in body temperature (Axelson, 1974; Hyatt et al., 2010; Kjellstrom & Crowe, 2011; Kjellstrom, Holmer, et al., 2009; Malchaire, Gebhardt, & Piette, 1999; Maloney & Forbes, 2011). High environmental heat exposure in excess can lead to insufficient thermoregulation and can lead to an increase in the risk of heat stress, heat related illnesses, heat stroke and even death (Bridger, 2003; Parsons, 2003).

Industries that are more exposed to high occupational heat exposures from the environment and from high physical demand include; agriculture, mining, construction, industries, military, and forestry (Bates & Schneider, 2008; Bonauto, Anderson, Rauser, & Burke, 2007; Crowe, de Joode, & Wesseling, 2009; Kjellstrom & Crowe, 2011; Slappendel, Laird, Kawachi, Marshall, & Cryer, 1993; U.S. Armed Forces, 2012; Wyndham & Strydom, 1969). These occupations are especially at risk in lower and middle income tropical countries, due to the combination of a hot environment, heavy physical work being the only source of income and income dependent on work output (Balakrishnan et al., 2010; Crowe et al., 2009; Kjellstrom & Crowe, 2011). The exposure to high heat can increase the risk of detrimental health outcomes, such as heat related illnesses, accidents and injuries (Kjellstrom, Kovats, Lloyd, Holt, & Tol, 2009). It also puts these workers at higher risk of being ill equipped to deal with increasing heat exposure and this can increase the detrimental health effects (Kjellstrom & Crowe, 2011). It has been outlined in the literature that when exposed to excessive heat at work, self-paced workers’ productivity decreases due to the physiological stress placed on their body during their work (Kjellstrom & Crowe, 2011). Research has hinted that workers in this situation feel powerless to deal with excessive heat as there is no incentive to choose their health over output and being paid piece by piece workers strive to reach their targets for economic purposes (Hanna, Kjellstrom, Bennett, & Dear, 2011). There is a growing amount of quantitative research looking at the impact of occupational heat exposure and building knowledge on the impacts of projected increases in temperature and humidity.
due to climate change. This includes a wide range of topics including how to effectively measure occupational heat exposure, consequences of excess occupational heat and effective management techniques of occupational health. This has been completed in a wide range of occupations and industries including fire fighting, military, mining, construction and forestry. All of which will be introduced in the literature review chapter in this thesis. However, there is little qualitative international research that looks into any of the vulnerable group’s perception and experiences of occupational heat exposure and heat related illness.

One study in England looked at perception of heat related risks to health among the elderly and found that the majority of participants did not consider themselves at risk of the effects of heat as they take appropriate steps to reduce these effects (Abrahamson et al., 2009). However, in the growing body of occupational literature there is a lack of research completed into why self paced workers put themselves at risk of excessive heat exposure that is detrimental to their health. Even more so is the lack of qualitative literature on the experiences of heat exposure in workplaces, and how workers respond to occupational heat.

The current research aims to contribute to filling the gap in the qualitative research of workers perceptions, responses and experiences of occupational heat. By using semi-structured questionnaires and thematic analysis this thesis aims to record and analyze workers experiences of heat in the New Zealand Sheep Shearing Industry. It will explore how variables in workplaces influence individual experiences and responses to occupational heat. This thesis will begin with a literature review in the following chapter. Chapter Three will introduce the New Zealand climate and sheep shearing industry. Chapter Four will discuss in detail the methodology, the methods of data collection and data analysis followed by the results in Chapter Five. Chapter Six will then discuss the implications of the results for the New Zealand Shearing Industry in the face of a changing global climate and an increasing frequency of hot days also in New Zealand.
Chapter Two: Reviewing the Literature

2.0 Aims of the Literature Review

The overall aim of this literature review was to identify, appraise and analyse both qualitative and quantitative literature on the effects of heat in the workplace, and particularly, workers’ experiences of heat.

2.1 Method: Search Strategy

2.1.1 Databases

Below is a list of the databases used to complete this literature review, I have also included a little bit of detail about what literature each database covers. To ensure that these were appropriate and that I wasn’t missing anything I was advised by a librarian at the University of Otago Wellington. Each database covers a different set of literature so it was important to complete the search in all of these databases to ensure all literature was captured.

- **MedLine**: Premier Health Research Database
- **Scopus**: Medical Sciences, Occupational Health and Agriculture
- **Informit**: New Zealand / Australasian
- **INNZ**: New Zealand / Australasian
- **Google**: Grey Literature

2.1.2 Search Strategy

<table>
<thead>
<tr>
<th>Concept 1</th>
<th>Concept 2</th>
</tr>
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<tbody>
<tr>
<td>Heat</td>
<td>Workplace</td>
</tr>
<tr>
<td>Heat exposure</td>
<td>Occupation</td>
</tr>
<tr>
<td>Heat stress</td>
<td>Occupational disease</td>
</tr>
<tr>
<td>High temperature</td>
<td>Occupational health</td>
</tr>
<tr>
<td>Hot Environment</td>
<td>Occupational exposure</td>
</tr>
<tr>
<td>Thermal Stress</td>
<td>Occupational Medicine</td>
</tr>
</tbody>
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Table 2.1: Shows the concepts used in the search strategy
I also set the following limits to the search strategy in the databases that allowed:

- English only
- Humans

Documents identified in this process were then previewed to see if the literature was relevant. Once identified as relevant the reference lists were also checked for relevant literature. This way documents would not be missed out.

### 2.1.3 Review Criteria

To reach my top two aims for the literature review I completed the above search strategy in the identified databases (Medline, Scopus, INNZ & Informit) and retrieved 596 documents. The next stage was to identify the relevant literature, to achieve this I read the titles of 596 and made a selection based on whether it was relevant to my specific aims or topic which allowed me to select 314 of the 596. In the next stage I read the abstracts and selected 242 as my final literature from the search strategy. In the last step I excluded any documents without abstracts, reviews before 1990, fire fighting research before 1990 (due to more recent reviews having been completed), and research on exercise performance with no occupational relation. I included those that measured any type of heat variable in an occupational setting or potentially relevant to an occupational setting. This allowed me to get the full text of the 50 remaining documents for further review. Following this I identified the relevant reviews from the list and read them in-depth identifying themes on the topic of my literature review. I also used these reviews to identify more references that may not have been picked up in the search strategy. Once I had identified these references I went on to reading the full texts of the documents and writing the review below with the following aim; to scope and analyse the qualitative and quantitative literature on the effects of occupational heat.

### 2.2 Qualitative Heat Literature

Qualitative literature on the experiences of heat in workplaces, as introduced earlier is limited. The topics covered that could be integrated to this topic in the available literature include; perceptions of occupational heat stress (Balakrishnan et al., 2010), symptoms of heat exposure and thermal discomfort. Although some papers claim to be qualitative research this was often not the case as they lacked a formal methodology, making it difficult to judge the quality of the work and the reliability of the results (Denzin & Lincoln, 2005). It is often perceived in the research world that using interviews and questionnaires are qualitative methods and therefore the research is qualitative (Patton, 1990). However if the results the qualitative collected data are analysed statistically then the research is
quantitative (Arcury et al., 2006; Balakrishnan et al., 2010; Haruyama et al., 2010; Mirabelli et al., 2010). A review of occupational heat stress in Canada outlined the need for more qualitative research into how occupational heat affects performance in the workplace and outlined that qualitative literature on this topic was sparse (Jay & Kenny, 2010).

Due to this lack of truly qualitative research in the area of occupational heat this literature review will review the quantitative literature on occupational heat stress. Firstly it will review studies that have claimed to be qualitative but analyse their data quantitatively (Arcury et al., 2006; Balakrishnan et al., 2010; Haruyama et al., 2010; Mirabelli et al., 2010). Secondly it reviews one quantitative study completed in the shearing industry on thermal strain and introduces other literature in the occupation of sheep shearing (Gun & Budd, 1995). This will be followed by a more in-depth review of occupational heat: its contributors, consequences and management techniques. The review will integrate studies completed in certain occupations throughout to highlight the occupations with more research than others.

2.2.1 Perceptions and Subjective Experiences of Occupational Heat Stress

A case study in Southern India assessed heat stress related perceptions in workers using a simple questionnaire (Balakrishnan et al., 2010). They revisited ten companies from a previous programme for industrial hygiene monitoring and assessed the perceptions of workers, managers, and health and safety professionals, accounting for a subsample of 1-5% of the total worker population in each company (Balakrishnan et al., 2010). The perceptions of workers and environmental measurements from the previous programme were linked and presented as separate case studies (Balakrishnan et al., 2010). The results indicated a wide variation in perceived risks from occupational heat and that current management techniques were insufficient in all sectors investigated (Balakrishnan et al., 2010). There was a disconnection between workers perceptions and their ability to manage occupational heat stress. The authors highlight the importance of improvements in management techniques for occupational heat stress due to anticipated changes in future temperatures (Balakrishnan et al., 2010).

In a questionnaire based study of 809 workers in Japanese industrial kitchens it was perceived to be hotter in gas kitchen compared with electric. The authors introduced the interplay of personal (age, gender and body mass index) and work related characteristics (years of employment, working hours and shift type) that contribute to workers experiences of heat (Haruyama et al., 2010).

Another study interviewed 300 Latino farm workers and compared workers behaviour to manage symptoms of heat of those with a seasonal work visa and those without (Mirabelli et al., 2010). Both
groups were able to use methods in their workplace to reduce the health impact of extreme heat and therefore the prevalence of heat illnesses (Mirabelli et al., 2010). In Costa Rica, 17 workers were interviewed with the aim of outlining working conditions and heat in the sugarcane industry. The report outlined the daily heat exposures of field workers in the industry and the behavioural adaptations needed to cope in the working conditions (Crowe et al., 2009). They highlighted the lack of research around the effectiveness of procedures in workplaces to manage heat these including hydration and clothing (Crowe et al., 2009).

Gun & Budd’s (1995) study of Australian sheep shearsers measured the subjective thermal responses to working when exposed to occupational heat (Gun & Budd, 1995). They measured this using a thermal sensation scale (Bedford seven point scale) and found that when radiant temperature in the workplace was higher so was thermal discomfort (Gun & Budd, 1995). They also found that productivity of workers stayed the same no matter what the thermal discomfort due to them having access to water (Gun & Budd, 1995).

The lack of qualitative research in the area of occupational heat exposure highlights the need for more well conducted qualitative research to be completed to investigate workers’ perceptions and experiences of occupational heat. This is especially important in occupations that may be more at risk of suffering from health related consequences such as self-paced, physically active, outdoor workers that are paid per unit of productivity. As introduced earlier the fire fighting industry seems to be the most well quantitatively researched occupation, due to its unique heat exposures and physical activity levels. However, it is important to be able to translate what is known in the well-researched occupations to those that aren’t, and to therefore understand the risks of occupational heat especially with the projected increases in temperature due to climate change. This includes how best to measure it and prevention and management techniques to reduce future health risks.

2.3 Sheep Shearing Literature

Perhaps the most important study to this literature review is a descriptive study of the effects of thermal, personal and behavioural factors on physiological strain, thermal comfort and productivity in shearers and wool handlers (Gun & Budd, 1995). The study ran January to March for two years, with 43 participants, 35 of which were shearers and eight wool handlers (Gun & Budd, 1995). They claimed to have a good cross section of the workers within the industry in Australia due to the wide variations in personal characteristics (Gun & Budd, 1995). They measured personal characteristics, energy expenditure, thermal environment, heat exchange, physiological strain, subjective responses (thermal comfort) to heat and productivity. They used multiple linear regression and general linear models to
analyse their data. Their overall conclusion was that shearers do not suffer from physiological strain from the exposure to occupational heat as they have effective behavioural responses such as drinking water to reduce the strain.

They also completed a retrospective study to assess the impact of varying temperature on productivity. Although comprehensive in their quantitative analysis of thermal strain in terms of heat measurements, contributing values and the related outcomes the study did not collect or analyse perceptions and experiences of the participants towards heat. Their measurements and collection of subjective responses (thermal discomfort) was completed on a seven point Bedford scale and was analysed statistically alongside other measurements. As this is the only paper to address thermal strain in the industry the lack of qualitative analysis completed by Gun and Budd (1995) outlines a clear gap in the literature for the current research. The specific results of the study will be discussed in each section of the literature review that it corresponds to. This will help to focus the review to the study population of the current research and the specific occupation of sheep shearing.

Other literature in sheep shearing industry has focused on the analysis of movements whilst shearing and injury risk, due to the repetitive nature of the occupation (Gregory, Laughton, Carman, Milosavljevic, & Callaghan, 2009; Harvey et al., 2002; Marshall & Burnett, 2004; Milosavljevic, Carman, Schneiders, Milburn, & Wilson, 2007; Milosavljevic, Milburn, & Knox, 2005). There has been a strong focus on the management and improvement of lower back pain in shearers with harnesses and lumbar supports (Milosavljevic, Carman, Milburn, Wilson, & Davidson, 2004). Carpal tunnel syndrome has been investigated in the industry (Monsell & Tillman, 1992) alongside an exposure model for pesticides (Villiere, 2001). A more recent topic that has been investigated in the sheep shearing literature is that of noise induced hearing loss, with studies highlighting that the noise generated by the cutting equipment to be at a dangerous level, in excess of 97dBA (Mahn & Pearse, 2011; McBride, Cowan, Utumapu, & Walaert, 2010). More research is being completed into ways to decrease the noise in the shearing sheds, through improvements in equipment such as the hand piece, gear set and the down tubes (Mahn & Pearse, 2011; McBride et al., 2010).

This introduction to the one shearing study that has been completed in the area of thermal strain (Gun & Budd, 1995) and also the other research in the industry highlights the gap for qualitative research within the sheep shearing industry. Qualitative research as a whole in the area of occupational heat stress is limited. The lack of literature on the shearing industry, including research using qualitative research methods, motivates the research undertaken in this thesis.
The remainder of this chapter will focus on quantitative literature on why occupational heat can pose health problems. The discussions will start by introducing thermoregulation in humans and the variables that impact on this. It will then discuss how occupations pose a unique threat in this area, followed by a review of the literature on measuring occupational heat, consequences of excessive occupational heat and the prevention and management of occupational heat stress. Throughout the review there will be summaries linking the literature back to the sheep shearing industry and integrating the Gunn & Budd (1995) article on thermal strain.

2.4 Thermoregulation

This section will introduce the main features of how humans thermoregulate, the variables that influence thermoregulation and will discuss the mechanisms of heat exchange. It will then introduce how workplaces provide unique settings for thermoregulation to be influenced by outside factors which can put workers at risk of excessive heat exposure.

Healthy adults have the ability to regulate heat efficiently through mechanisms which keep the body at thermal equilibrium (Kilbourne, 1992). This equilibrium is 37°C ± 0.5 (Bridger, 2003; Parsons, 2003). Slight deviations (1-2°C) either side of this equilibrium can cause interruptions in the body’s systems and can be fatal (Bridger, 2003; Taylor, 2006). Heat exchange between the body and the environment is the central way to maintain this equilibrium, which is heat transfer (Epstein & Moran, 2006; Parsons, 2003). Heat transfer is most simply explained by a thermal gradient, when a transfer of heat occurs from one surface/object to another down a temperature gradient from hot to cold. If the temperature within the human body is greater than that of the surrounding environment then heat loss takes place, and if the surrounding air is hotter than the body it experiences a heat gain (Bridger, 2003; Parsons, 2003). There are three variables which influence the effectiveness of heat exchange: physiological mechanisms of heat regulation, behavioural variables and environmental variables. All these variables act through the heat exchange parameters of radiation, convection and most importantly evaporation (Bridger, 2003; Parsons, 2003).

2.4.1 Physiological

The physiological mechanisms for heat regulation have been reviewed extensively elsewhere (Kilbourne, 1992). Therefore I will use this section to introduce how the body physiologically reacts to heat through a thermoregulatory response. This response is initiated through a hierarchy of structures in the central nervous system, and initiates the body’s heat loss mechanisms of vasodilatation and perspiration (Boulant, 2000; Gordon & Heath, 1986; Romanovsky, 2007). These mechanisms increase heart rate and redirects blood away from organs to the surface of the skin where it can cool, with the
aim of maintaining the 37°C core body temperature. This acts through the most effective heat loss parameter which is evaporation, which occurs with sweating (Keim, Guisto, & Sullivan, 2002; Taylor, 2006). Both physiological mechanisms can effectively maintain the body’s thermal equilibrium depending on the two other behavioural changes and environment variables.

2.4.2 Behavioural

Behaviour strongly influences how the body is able to thermoregulate and works alongside the physiological structures to allow the body to survive in an environment when heat is extreme. Mechanisms of this kind include; hydration, physical activity (leads to metabolic heat production), rest, and clothing (Bridger, 2003). These behavioural mechanisms are the reasons behind why some occupations are at a higher risk from excessive heat exposures than others and are also the variables that make heat exposure difficult to measure. They interact closely with the physiological mechanisms but are also influenced largely by the environmental variables.

2.4.3 Environmental

The environmental variables include: ambient temperature, humidity, air velocity (wind speed) and radiant temperature (Bridger, 2003; Parsons, 2003). These variables create the environment around the body and the interaction with physiological responses and behaviour completes the human thermal environment. These environmental measures interact with the body during heat exchange (Bridger, 2003; Parsons, 2003; Taylor, 2006). In brief, ambient temperature is known as the temperature which determines heat flow between the body and air, or the temperature of air which surrounds the body (Bridger, 2003; Parsons, 2003). Humidity is the amount of water vapour in the air, and can be thought of in two ways: relative and absolute. It is the absolute humidity which determines the evaporative heat loss between the skin and surrounding environment (Bridger, 2003; Parsons, 2003). Air velocity is the movement of air across a body, which affects the rate at which hot air or water vapour is removed from the body (Bridger, 2003; Parsons, 2003). Radiant temperature determines heat exchange between two objects or surfaces that radiate heat, if the surrounding air is hotter than the body it leads to heat gain and vice versa (Bridger, 2003; Parsons, 2003). The combinations of these environmental variables influence the effectiveness of heat exchange and therefore how the body deals with heat in certain situations (Taylor, 2006).

2.5 Occupational Heat Stress

Working environments provide challenging and unique situations where all three sets of variables introduced above interact and influence how well the body is able to thermoregulate. The most
outstanding element in the occupational setting is that people (workers) are in a situation where they receive remuneration from their work. This aspect adds a motivation for workers to be productive as without the remuneration workers would not be able to live their lives. This is especially of concern with workers paid per piece (Kjellstrom, Holmer, et al., 2009). It is important to consider this aspect when looking at heat exposure and heat regulation in the workplace, as it can put pressure on the worker to be productive in situations at a detriment to their health.

Workplace heat exposure has been studied in different occupations, many of which include consideration of; the physicality of the work (metabolic heat production), different sources of heat in the workplace (sunlight, furnaces, cupolas and fires), protective clothing and access to water. (Tanaka, 2007). Most importantly Tanaka (2007) outlines the influence that these different situations have on the body’s ability to perform in the working environment.

The most extensive literature in this field is in the fire fighting industry (Barr, Gregson, & Reilly, 2010; Budd, 2001b; Cheung, Petersen, & McLellan, 2010; Van Gelder, Pranger, Wiesmann, Stachenfeld, & Bogucki, 2008). This is due to the distinctive tasks of the job, the physicality of the work and also the unique exposure to a heat source (fire) in a high pressure situation (Cheung et al., 2010). Two recent reviews, Barr et al. (2010) and Cheung et al. (2010) looked at the physiological and ergonomic challenges faced whilst fire fighting. Both reviews agreed on the physical demands of the work in terms of worker’s aerobic fitness (VO\textsubscript{2} max) stating that a VO\textsubscript{2} max (maximal oxygen consumption) of 34ml.kg.min\textsuperscript{-1} is needed for optimum performance. This conclusion was reached due to the strong relationship between work intensity and duration in the literature, even though there were varied methods of measuring VO\textsubscript{2} max (Barr et al., 2010; Cheung et al., 2010). When dealing with occupational heat, fitness allows optimal performance in all areas and therefore more efficient thermoregulation. At a higher VO\textsubscript{2} max the more efficient workers will be to perform better in situations where heat is excessive. One study in ergonomics of the shearing industry found that shearers had a VO\textsubscript{2} max of 2.42 l.min\textsuperscript{-1}, when converted to a relative scale of a 70kg male the VO\textsubscript{2} max is similar to that required of fire fighters at 34.5 ml.kg.min\textsuperscript{-1} (Payne, 1998). For optimal performance in both fire fighting and sheep shearing a VO\textsubscript{2} max of approximately 34ml.kg.min\textsuperscript{-1} is an ideal level of fitness. A more common measure of energy expenditure in the workplace is Watts (W); this is the amount of work per unit of time. Gun and Budd (1995) measured the energy expenditure of 35 shearers in the workplace and found it to be 390W - lower than the 555W previously measured in a lab based study (Poole & Ross, 1983). This shows the differences in energy expenditure between field studies and lab based studies, which has also been a problem in the fire fighting literature when determining physiological responses to heat.
The majority of the studies reviewed on the physiological response of fire fighting were lab based studies and the reviews call for more real life operations and field based research to be completed (Barr et al., 2010; Cheung et al., 2010). Heavy protective clothing reduces the evaporative capacity of heat loss due to sweat being absorbed into the clothing (Barr et al., 2010; Cheung et al., 2010). These microenvironments between the body and the clothing layers may lead to un-compensable heat stress (UHS) (Barr et al., 2010; Cheung et al., 2010). The protective clothing has been shown to increase metabolic rate, oxygen consumption, heart rate and perceived effort which would also contribute to the UHS of the workers (Barr et al., 2010; Cheung et al., 2010). The clothing worn during sheep shearing includes cotton singlets, shearing jeans, moccasins (leather shoes) and socks, (Gun & Budd, 1995). This clothing is not considered protective clothing with the jeans being the only heavy and hard wearing item; this would therefore not affect the evaporative capacity of sweat and thermoregulation as is discussed in fire fighters.

A lab based experiment on nine volunteer fire fighters was completed to establish an experimental model of UHS (Van Gelder et al., 2008). A simulation of fire fighting tasks with full protective clothing and breathing apparatus was conducted in an environmental chamber and core body temperature was measured using an orally ingested capsule. They argue that their experimental model of UHS could be used for future research using it as a control against future field studies. To date, however, no empirical studies have used this method, with a field study group as comparison. Barr et al. (2010); Cheung et al. (2010) outline that there is a lack of agreement of where to measure thermal environment (ambient temperature and radiant temperature) in real life field studies and highlight this a potential reason why there is a lack of recent research on real life situations of fire fighting. A series of 13 papers describing the Aquarius project assessed the ability of fire fighters to safely suppress bushfires with hand tools (Brotherhood et al., 1997; Budd et al., 1997; Budd, Brotherhood, Hendrie, Cheney, & Dawson, 1996). They describe how fire fighters behavioural regulation of work rate and sweating allows stability in heart rate and rectal temperature even when exposed to excess occupational heat (Budd, 2001b).

The physiological response of construction workers was measured by Bates and Schneider (2008) in the United Arab Emirates. Their results of 22 volunteer workers core temperature and heart rate, over nine study days showed that workers were not physiologically challenged at work. This could have been because the environment measurements did not suggest potential heat stress to workers but could also be due to workplace practices already in place. A study of 12 male construction workers in Japan found that the workers were not exposed to high levels of heat stress and their behaviour to
manage the effects of heat was sufficient for them to work safely within their limits (Morioka, Miyai, & Miyashita, 2006).

Forestry workers in Japan were asked to record their symptoms of heat stroke at work through a self-reported questionnaire (Maeda et al., 2006). In the forestry industry the main source of heat, like military workers, is metabolic heat production, with many harvest methods and planting involving hard physical labour and radiant heat from working outdoors. One third of the study population reported heat stroke symptoms with the longer serving workers being less likely to report suffering from heat stroke symptoms (Maeda et al., 2006). Construction has been identified as an at risk occupation of excessive heat in a review of heat stress standards in hot workplaces in Japan (Tanaka, 2007). It was also identified in an epidemiological study evaluating occupations at risk of heat related illness other than the military in Washington USA (Bonauto et al., 2007). This would make sense as often construction work is physically active, with the majority of work being outside exposed to radiant heat, they wear protective clothing, and this is more of a concern in hotter tropical and subtropical countries. Bonauto et al. (2007), when identifying the occupations with the most heat related illness over the 11 year study period did not control for potential confounders such as medications and vulnerable at-risk populations.

Other occupations in which heat exposure in the workplace has been investigated include; mining (Donoghue, Sinclair, & Bates, 2000), industrial workers (Brake & Bates, 2002; Chen, Chen, Yeh, Huang, & Mao, 2003), traffic workers (Inaba & Mirbod, 2007), agricultural workers (Crowe et al., 2009; Nag, Nag, & Ashtekar, 2007) and shearers (Gun & Budd, 1995). All of these occupations are exposed to heat from different sources including exposure to radiant heat (working outside), high levels of physical activity (metabolic heat production) and/or an occupational source of heat (furnace, cupola). All of which, as mentioned earlier, influence how effective the body is at heat exchange and, therefore, how workplaces can exacerbate the risk of heat related health impacts.

Occupations provide a unique environment for individuals to thermoregulate. This depends on physiological, behavioural and environmental variables of heat exchange whilst also being dependent on the occupational specific variables such as task intensity and duration. Having introduced the variables that are important to occupational heat exposure it is pertinent to review the literature on measuring occupational heat. This discussion will introduce how occupational heat has been measured and introduce guidelines around heat in workplaces.
2.6 Measuring Occupational Heat Exposure

Measuring heat and the impact it has on individuals or populations sounds like a relatively simple task on the surface until you consider the amount of variables influencing the thermal environment. As introduced in the previous section there are three sets of variables that influence this: physiological, behavioural and environmental variables. Due to the complex nature of how these variables interact, there is much debate in the literature on how to effectively measure heat stress worldwide, and no gold standard measure. Although some studies as introduced earlier measured the subjective experiences of heat there is a lack of validated methods.

There are more than 300 heat indices that aim to assess heat and the health effects in specific settings including workplaces. Measures of thermal stress should include two behavioural variables; clothing and metabolic rate (work rate), and four environmental variables; ambient temperature, radiant temperature, humidity and air velocity (Budd, 2001a; Epstein & Moran, 2006). There have been many proposed indices that include physiological measurements; however this introduces a lot of biases when looking at heat at a working population level. Indices of heat stress can be divided into three categories: rationale indices, empirical indices and direct indices (Epstein & Moran, 2006). Epstein & Moran discuss the strengths of each type of index and the applications within a workplace setting. They argue that although rationale and empirical indices are more accurate, direct indices allow for simple and practical assessment of the workplace thermal environment (Epstein & Moran, 2006). An example of a direct heat index is wet bulb global temperature (WBGT), this is the most widely used heat stress index worldwide (Budd, 2001a, 2008; Epstein & Moran, 2006; Hancock, Ross, & Szalma, 2007; Jay & Kenny, 2010; Kjellstrom, Holmer, et al., 2009; Parsons, 2006; Tanaka, 2007; Taylor, 2006; Webster, 2004).

WBGT is an index that measures the thermal environment based on environmental variables; ambient temperature, relative humidity, air flow and radiant heat (Parsons, 2003). It then uses an algorithm which describes the human physiological response to the environment and has correction factors for the behavioural variables including metabolic rate and clothing (Epstein & Moran, 2006). Thus, a distinction needs to be made between WBGT as a measure of the thermal environment, and its interpretation as a tool to prevent occupational heat stress. WBGT fits Epstein & Moran’s criteria for a universal measure as it is a measure of the environmental variables and corrects for behavioural variables. However, it is by no means classified as the gold standard and although it has the status of the most widely used index, it is still widely criticised; with the physiological efficacy (ability to
determine the physiological responses), the equipment and the interpretation of WBGT being questioned (Budd, 2008; Epstein & Moran, 2006; Jay & Kenny, 2010; Parsons, 2006; Taylor, 2006).

One review solely focussed on the history and limitations of WBGT, calling for more careful interpretation guidelines of the index and the need for a more accurate index (Budd, 2008). The physiological efficacy was evaluated and showed that the estimation of metabolic heat production through coefficients rather than actual measurements is inaccurate (Epstein & Moran, 2006; Kenney, Lewis, Anderson, & Kamon, 1986; Taylor, 2006). It is also argued that WBGT is not a useful measure for clothed workers and inappropriate in those wearing encapsulated garments (Taylor, 2006). However, a more recent WBGT for clothed workers has been proposed with the claim of increasing the validity and the reliability of the index (Parsons, 2006). The final criticism of WBGT is the need for specialised equipment and the lack of calibration guidelines for the equipment (Budd, 2008). This could be the reason behind the claim that WBGT is insensitive to wind speed over 1.5m.s\(^{-1}\) in hot humid conditions, and overemphasis of dry bulb temperature close to the top end of the scale (Taylor, 2006). The specialised equipment used to measure WBGT is a small price to pay given that it is the most widely used index to measure heat stress, and given the need for an increase in research due to projected temperature increases.

Many of these limitations of the WBGT has led to it being compared to other heat indices including; the discomfort index (Epstein & Moran, 2006), the predicted heat strain model (Malchaire, 2006), Thermal Work Limit (Bates & Schneider, 2008), Humidex and Wind chill (Callejon-Ferre, Manzano-Agugliaro, Diaz-Perez, & Carreno-Sanchez, 2011; Jay & Kenny, 2010). In cases where the WBGT cannot be used, for example occupations wearing encapsulated garments, other measures have been used to assess the thermal stress workers are under, including skin temperature and ingested core temperature (Pryor et al., 2012).

Given its limitations, WBGT has been used to set international standards regarding the measurement of heat stress, ISO7243:1989 *Hot environments -- Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)* (ISO, 1989). This standard allows for the assessment of hot environments with its main concern being the ergonomics of the thermal environment (ISO, 1989). Parsons (2006) assessed the validity, reliability and the application of ISO7243, advising an analytical approach to the guidelines of WBGT if reference value limits are exceeded, a now accepted limitation to the index. Based on this ISO standard thermal limit values (TLV) were set by the American Conference of Governmental Industrial Hygienists (ACGIH, 2007) which are said to protect workers from extreme thermal stress (Tanaka, 2007). This recommends work to rest ratios for a given WBGT at
specific work intensities (ACGIH, 2007). The next section will review literature on the consequences of occupational heat when workers are exposed to it in excess.

2.7 Consequences of Excessive Occupational Heat Exposure

As we now understand the three variables contributing to thermoregulation, how to measure it and the difficulties this poses, this section will review the literature on what happens when thermoregulation fails; the consequences of excessive heat. Firstly the impact of heat on overall performance is introduced, with a discussion into the impacts this can have on people in the workplaces following. The consequences of excess heat exposure will then be linked to the occupation of shearing to bring in the focus towards the current research. The difficulties in measuring heat introduced earlier transfers over to attributing the consequences of heat due to the many different variables that can contribute to this state.

The general effects of heat with regards to overall health are reviewed by many and are often referred to as heat related illness or heat syndromes (Jay & Kenny, 2010; Keim et al., 2002; Tanaka, 2007; Yoopat, Toicharoen, Glinsukon, Vanwonterghem, & Louhevaara, 2002). The reviews discuss the symptoms and effective treatments of; heat rash, heat cramps, heat syncope (fainting), heat exhaustion and heat stroke (Jay & Kenny, 2010; Keim et al., 2002).

These heat related illnesses have been researched drawing links with general workplaces and then studied in specific occupations. Tanaka (2007) reviewed the occurrence of heat stroke in Japan workplaces and found a high incidence of heat stroke in indoor workers over the ages of 60 years. The risk of heat stroke was higher in the agricultural, industrial and construction industries, due to the outdoor physical nature of the jobs (Tanaka, 2007). One study in the mining industry examined the clinical state, incidence, personal risk factors, haematology and biochemistry of heat exhaustion occurring at deep underground mine, using a one year prospective case series of acute heat exhaustion (Donoghue et al., 2000). Heat exhaustion and heat cramps were associated with dehydration, with the incidence of heat exhaustion increasing with the increased depth of mine and increasing in the summer months (Donoghue et al., 2000). WBGT averaged 31.5°C at the site of heat exhaustion occurrence (Donoghue et al., 2000). Reviews have also introduced how increasing exposure to heat can increase injury risk in some occupations (Jay & Kenny, 2010; Tanaka, 2007). A surveillance study of the US military used ICD codes of heat related illnesses over a five year period (2007-2011) and showed 362 incidents of heat stroke and 2652 other heat related injuries (2012). Their results reported heat injuries at over 200 military sites worldwide (U.S. Armed Forces, 2012). Another study looked at heat strain using WBGT and found that auxiliary type jobs are more at risk of
physiological strain in Thailand, and that it is not only heat exposure but also muscular work of tasks that increases the risk of heat strain (Yoopat et al., 2002). It has also been identified in a review of forestry workers that heat can affect fatigue, discomfort and therefore increases risk of risky workplace behaviours which have been linked heat related injuries (Slappendel et al., 1993).

Another consequence of heat that is discussed in the literature is decreased performance and increased discomfort, leading to decreased productivity and in turn economic loss (Tanaka, 2007). Different thermal environments and the impact on performance have been researched in a meta-analysis (Hancock et al., 2007). The aim was to quantify the effect of thermal stressors on human performance. Although their review did not cover specific occupations, their results indicate the effects of heat on performance outcome measures are large enough to be generalised to workplaces (H Hancock et al., 2007). Hancock et al. (2007) outline the difficulties in this research area as performance is dependent on a combination of variables making the heat exposure; the tasks intensity and duration, and the task type and performance measures being used. They argue that performance and thermal stress can be described best by the “extended U theory”, where performance is relatively stable at a central plateau and bound by sections of evident failure, as proposed by Hancock and Warm (1989). They highlight a clear heat stress intensity effect, increasing across temperatures with large variations of performance tasks affected at the highest temperature extremes. Shorter exposures to heat in excess resulted in greater degradation of performance tasks (H Hancock et al., 2007). It was concluded that heat has a negative effect on human performance of certain tasks including; perception tasks (where heat leads to a reduced response accuracy and increased time), cognitive tasks (heat does not affect response time but reduces accuracy) and psychomotor tasks (heat detrments accuracy but facilitates speed with task specifics being the deciding factor on whether it is detrimental) (H Hancock et al., 2007). Although this was clear in their analysis they still outlined the need for more research into heat and performance due to the confounding effect of acclimatisation (H Hancock et al., 2007). This is in agreement with a narrative review looking at the consequences of heat in workplaces in Canada, Jay & Kenny (2010) who completed this review agreed that there was a decrease in motor responses due to heat and that the cognitive performance was affected (Jay & Kenny, 2010).

Another review in 2003 assessed the mental capacity of workers in heat in both acclimatised and unacclimatised men; they observed deterioration in mental capacity when the room temperature exceeds 30–35°C, with optimum temperature for unacclimatised people and mental capacity to be ~25°C (Rodahl, 2003). One study found no significant difference in cognitive function scores pre and
post exertion in ten unacclimatised men, this may have been attributable to the low participant numbers and the lack of control of confounding in this study (O'Neal & Bishop, 2010).

The impact of dehydration (from heat exposure) on cognitive performance has also been researched (Jay & Kenny, 2010) (Hancock et al., 2007). Reviews outline measurement error and caffeine intake as potential confounders but agree that when an individual is 2% or more body weight dehydrated it is detrimental to cognitive performance including; attention, short term memory loss and visual-motor tracking (Hancock et al., 2007; Jay & Kenny, 2010; Kenefick & Sawka, 2007), with the dependant variables being length and type of task. In workplaces there is a lack of research on cognitive performance, on review in fire fighters questioned whether it was physiological stresses (e.g. heat stress) or the psychological stresses of the job that affects the performance of mental and physical tasks (Barr, Reilly, & Gregson, 2011).

Dehydration as a consequence of heat stress has been reviewed relative to workplace practices accounting for individual variations in people and particular workplace activities that contribute to water loss (Kenefick & Sawka, 2007). The main mechanism water is being lost through sweat and is dependent on task intensity and duration (Kenefick & Sawka, 2007). The review measures dehydration through percentage body weight lost and indicates that greater than two percent can contribute to an increase in core temperature during physical work, reduced sweat rate, increased heart rate and decreased aerobic performance (Kenefick & Sawka, 2007). These responses can mediate accidents in the workplace and influence workers reaction time when compared with well hydrated workers (Kenefick & Sawka, 2007). They discussed that wearing protective clothing can increase sweat rate to 2.25L/h in a simulation which introduces another difficulty in maintaining fluid balance in workplaces (Kenefick & Sawka, 2007). They also highlight other workplace variables that may influence this such as access to water and bathroom facilities (Kenefick & Sawka, 2007).

Dehydration and sweat losses were measured in the shearing study assessing the thermal strain of 35 shearers (Gun & Budd, 1995). It was found that the average sweat loss was 6.1kg, of which 72% was replaced by drinking leaving the average dehydration at 2.8% body mass (Gun & Budd, 1995). They also found that all participants sweated more in hotter weather, passed less urine and drank more water reducing overall dehydration (Gun & Budd, 1995). Although drinking more water in hotter weather reduced dehydration there was still an average of 2.8% deficit that the workers experienced which could potentially lead to further health problems if this is a daily occurrence.

Recently there has been some research into the long term effects of occupational heat exposure on kidney function (Peraza et al., 2012) and kidney stones (Atan et al., 2005). A population based cross
sectional survey investigated the prevalence of decreased kidney function, measuring serum creatinine (sCr) and glomerular filtration (eGFR) in 256 men and 408 women from five different communities responsible for the production of sugarcane and coffee (Peraza et al., 2012). They found a higher prevalence of decreased kidney function in workers in the sugarcane and cotton communities, with 30% of male population in coastal communities with elevated sCr and eGFR (Peraza et al., 2012). Although their study was descriptive and there was potential for underreporting of alcohol use, these results were alarming. Similarly a study in 2005 retrospectively looked at the incidence of urinary lithiasis in males in the steel industry (Atan et al., 2005). They found statistically significant differences (p<0.001) in the urinary lithiasis and metabolic evaluations of workers in the hot areas compared with other workers (Atan et al., 2005). The long term impacts of heat exposure on semen parameters have also been investigated. One study highlighted that although there is an association of heat and semen parameters, a recent study in a steel casting plant in 99 workers shows no significant differences between workers in hot environment versus cold (Momen, Ananian, Fahmy, & Mostafa, 2010).

Health impacts aside, an important yet overlooked consequence of occupational heat exposure is the effect on work output and productivity (Gun & Budd, 1995; Keim et al., 2002; Kjellstrom, Gabrysch, Lemke, & Dear, 2009; Kjellstrom, Holmer, et al., 2009). It has regularly been an afterthought measure in the current literature and not a defined variable from the outset. This may be due to the other variables measuring productivity that are not considered important in other research including; attitudes to work and motivation to complete work in the given environments (Rodahl, 2003). In 2009 a health research and prevention programme aimed at quantifying the extent of hot exposures (with regards to climate change) on working people began, called 'Hothaps: high occupational temperature health and productivity suppression' (Kjellstrom, Gabrysch, et al., 2009). This paper outlines a study protocol and calls for studies to be completed in the area of occupational heat to gain local and national research on the topic of productivity and the impact on different working populations (Kjellstrom, Gabrysch, et al., 2009). The outline highlights workers at high risk of lower productivity in the future due to heat exposure, including those in outdoor heavy physical work in low and middle income tropical countries (Kjellstrom, Gabrysch, et al., 2009). The productivity of people working in conditions where heat exposure is excessive depends on behavioural factors such as self pacing, water replacement, work to rest periods (Singh, Bhardwaj, & Deepak, 2010). If these behavioural factors are undermined by the production requirements and physical labour does not decrease, it can lead to serious health effects (Hyatt et al., 2010). This in turn would lead to a decline in productivity if the worker/s gets too ill to work. The study assessing the productivity and thermal strain in sheep shearers found no change in productivity even when WBGT and Thermal Limit Values (TLVs) were over the
recommendations (Gun & Budd, 1995). They highlighted that warmer weather outside was correlated to higher rectal temperature and the workers were more uncomfortable but no less productive (Gun & Budd, 1995). This could have been influenced by the workers being paid per output and the motivation for them to continue with productivity was the economic incentive. However this study may have also been subject to measurement error when assessing productivity due to there being no measure of aerobic capacity, work rate and shearing skill. Although difficult in a field study it would have given a more accurate estimate of productivity (Gun & Budd, 1995). This is an example a competing situation in terms of heat, workers’ health and productivity in a working environment. Behavioural factors are more difficult to measure in occupational settings and this may be why the literature is thin in this area. Productivity and the effects of air conditioning have been measured on indoor office workers. However, these workers are the least likely to be negatively affected by heat exposure (Kjellstrom, Holmer, et al., 2009).

To summarise, the consequences of excessive occupational heat exposure are: heat related illnesses, decreased physical and cognitive performance, dehydration all of which lead to a potential decrease in work rate and productivity. Figure 2.1 below shows all the complex interactions between factors that can affect human performance in the workplace and therefore productivity. Due to the long term health effects of excessive occupational heat exposure introduced in this section it is important to review literature on the prevention and management techniques used in different occupations to ensure the short term consequences and the long term health effects are reduced.
2.8 Prevention and Management of Occupational Heat Stress

Having introduced the health related consequences of occupational heat it seems logical to discuss the prevention and management of it in workplaces. Due to the complexity of variables contributing to heat there have been many different approaches to management of heat in different occupations in different parts of the world. This section will introduce the use of guidelines to manage heat and then review the literature on different procedures used to minimise and prevent the negative consequences of heat discussed above.

When discussing occupational heat there are regulations in most countries, no specific regulations enforced for any occupation, except for the military. Therefore, it is important to understand heat from an occupational setting and one way to do that is to acknowledge the International Labour Organisation's (ILO) statement on heat. It recognises that occupational heat has the potential to overwhelm the body's thermoregulatory mechanisms, and should be identified and recognised as a potential hazard, and therefore managed in this way (Kanawaty, 1992). Malchaire et al. (1999) outlined that the best strategy for the evaluation of the risk of thermal environments in the workplace is to follow a structured and participatory four stage approach: screening; observation; analysis; and
expertise. The ILO guidelines suggest the most effective ways to manage occupational heat are: adequate supervision; ventilation; adequate rest breaks; appropriate mechanical aid; protective clothing; and supply of clean drinking water (Kanawaty, 1992). These are fitting as we have discussed each of these to have an impact on the body’s thermoregulation in the workplace and are similar to the guidelines from the National Institute of Occupational Health and Safety (NIOSH) (NIOSH, 1986). The International Standards Organisation have published similar guidelines (standards), which are used in many countries as reference points (Parsons, 2003). At the moment there are only guidelines regarding adequate rest breaks - the others are still being researched with regards to the specifics in each workplace.

Work to rest ratios have been set by ACGHI in the form of thermal limit values (TLVs) (ACGIH, 2007). These take into account the environment a worker is exposed to and considers individual factors tailored to their work including; physical workload, acclimatisation and protective clothing. The guidelines were written based on ISO7243, which uses WBGT as a reference guide with the aim of ensuring that the majority of workers do not exceed the upper limit of core temperature of 38°C, set by the World Health Organisation (ACGIH, 2007; Tanaka, 2007; WHO, 1969). The TLVs and recommended work to rest ratios are shown in Table 2.2. They recommend work to rest ratios (%), for a WBGT (°C), for different work intensities (ACGIH, 2007; Tanaka, 2007). Guidelines using the WBGT method have been proven to reduce casualties from many heat related illness outbreaks in US Army and Marine in 1950’s (Budd, 2008; Epstein & Moran, 2006).

<table>
<thead>
<tr>
<th>Metabolic rate class (work intensity)</th>
<th>1 (light work) WBGT (°C)</th>
<th>2 (medium work) WBGT (°C)</th>
<th>3 (heavy work) WBGT (°C)</th>
<th>4 (very heavy work) WBGT (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% rest/hour (Continuous work)</td>
<td>31</td>
<td>28</td>
<td>27</td>
<td>25.5</td>
</tr>
<tr>
<td>25% rest / hour</td>
<td>31.5</td>
<td>29</td>
<td>27.5</td>
<td>26.5</td>
</tr>
<tr>
<td>50% rest / hour</td>
<td>32</td>
<td>30.5</td>
<td>29.5</td>
<td>28</td>
</tr>
<tr>
<td>75% rest / hour</td>
<td>32.5</td>
<td>32</td>
<td>31.5</td>
<td>31</td>
</tr>
<tr>
<td>100% rest / hour (No work at all)</td>
<td>39</td>
<td>37</td>
<td>36</td>
<td>34</td>
</tr>
</tbody>
</table>

Table 2.2: Shows the recommended maximum WBGT exposure levels (°C) at different work intensities and rest/work ratios for an average acclimatise worker wearing light clothing, approximate to ISO standards and recommendations by NIOSH, sourced from Kjellstrom, Holmer, et al. (2009).

Studies have found conflicting results of the application of TLVs in different occupations in ensuring that workers core temperature did not exceed 38°C. Examples include it being found accurate in sheep shearing in Australia (Gun & Budd, 1995) but not so in glass manufacturing in India (Srivastava, Kumar, Joseph, & Kumar, 2002). This suggests that the use of TLVs may not be suitable for occupations in
tropical and sub-tropical countries, also the application of TLVs in occupations that are paid per output need further investigation (Parsons, 2003).

WBGT was used to measure the thermal environment in the thermal strain shearing study. They also compared their measurements to the TLVs (Gun & Budd, 1995). They highlighted that WBGT was closely correlated to variations in rectal temperature, thermal comfort and sweat loss but not productivity (Gun & Budd, 1995). During the study, 43% of their observations were over the TLVs as set by ACGIH (Gun & Budd, 1995). However, WBGT was only over TLV four out of fifteen times when rectal temperatures of the shearers exceeded 38°C (Gun & Budd, 1995). This would mean that if the guidelines and the TLVs were followed, there would have been a decrease in productivity and the earnings for the shearers (Gun & Budd, 1995).

Aside from guidelines on work to rest ratios another important workplace practice for managing heat in the workplace is cooling, with the aim of cooling to return the body to its normal physiological state when exposed to excess occupational heat. There are different mechanisms of cooling with the most popular being cooling garments and body submersion. One study assessed the effect of liquid cooling garments on recovery and performance time in people wearing fire fighters ensemble (Kim, Coca, Williams, & Roberge, 2011). They found that the use of a whole body cooling garment worn under protective clothing improves recovery time (Kim et al., 2011). The use of a cooling garment was also elevated in the power industry in Japan by simulating tasks in a controlled indoor environment and uncontrolled outdoor setting (Furtado, Craig, Chard, Zaloom, & Chu, 2007). They agreed with Kim et al. (2011) in that cooling suits provide a better microclimate for the body when exposed to hot environments and wearing protective clothing.

Both studies had small sample sizes. In addition, the lack of significant change in physiological recovery variables mean it is not clear that results can be generalised to both working populations (Furtado et al., 2007; Kim et al., 2011). A laboratory based study of ten volunteer fire fighters compared the physiological response to cooling via forearm submersion and leg submersion following exercise (Katica et al., 2011). They found that leg submersion during recovery had a positive impact on work tolerance time, but this was not statistically significant. There was no difference (between the arm and leg groups) in heart rate, rectal temperature and perceived exertion (Katica et al., 2011). Pre-cooling via whole body submersion pre occupation has been suggested in a review as a way to reduce cardiovascular strain in the heat, whilst improving endurance ability in physical occupations (Taylor, 2006). The review highlights the limitations in the application of cooling in workplaces but suggest it may delay the onset of fatigue, reduce core temperature and assist with heat loss prior to heat exposure (Taylor, 2006).
Barr et al. (2010), reviewed recovery strategies in the fire fighting industry and found that the most effective way of recovering normal physiological functions was forearm submersion (Barr et al., 2011). In their review they also highlighted the importance of hydration before, during and after work, which align with the results of other reviews of a similar nature (Barr et al., 2010; Cheung et al., 2010; Keim et al., 2002; McLellan & Selkirk, 2006). The review by Cheung et al. (2010) goes further and outlines the need for a multidisciplinary health and safety programmes with hydration as the main focus to reduce thermal and cardiovascular strain of fire fighters.

Hydration (when exposed to heat) and performance have been reviewed in athletes (Murray, 2007), long term shifts in mining (Brake & Bates, 2003), manual labour (Ishikawa, Tamura, Ishiguro, Yamaguchi, & Minami, 2010), and as mentioned previously fire fighting (Barr et al., 2010; Cheung et al., 2010; Smith, 2011). One study with 39 male participants completed a comparison study measuring whether hydration practices were sufficient in shift workers in mines, and found that although beginning the shift slightly under-hydrated that the average intake of 0.8l/h was sufficient in hot jobs (Brake & Bates, 2003).

Another aspect in the workplace is whether there is a difference in hydrating using water and rehydration solutions. A randomised crossover design was used to study the effects of oral rehydration on fatigue in manual workers over hot periods of summer, in 153 workers at Tokyo airport (Ishikawa et al., 2010). Their results indicate a significant difference between fatigue scores (visual analogue scale) of workers who drank rehydration solution compared with those drinking usual beverages (Ishikawa et al., 2010). However, intake of hydration solution was self-reported using questionnaires (subject to measurement error) and fatigue was not measured before work so researchers were unable to compare the relative scores and contribute fatigue to working in the heat as many other variable could contribute (Ishikawa et al., 2010).

One review suggests guidelines for workplace hydration programmes to maintain the health of workers that are exposed to occupational heat (Kenefick & Sawka, 2007). They highlight the importance of education to workers about maintaining their own hydration status which is supported by others (Brake & Bates, 2003; Keim et al., 2002). They discuss that (Kenefick & Sawka, 2007) when measuring hydration status of workers in general, urine colour and thirst have been proven to be the most effective and should be incorporated into the fluid replacement programme. They also stress the importance of including established meal breaks as eating helps promote the thirst response and may assist in restoration of fluid balance in heat exposed workers (Kenefick & Sawka, 2007). Their focal point of the fluid replacement programme was specificity in terms of work intensity, work environments and work to rest ratios (Kenefick & Sawka, 2007). There are no specific guidelines in the
review of how much water is to be consumed at a given temperature and work rate. However, they give an example of how a fluid replacement programme was successful in the US military shown in table 2.3 (U.S. Department of the Army and Airforce, 2003)

<table>
<thead>
<tr>
<th>Heat Category</th>
<th>WBGT Index, °F</th>
<th>Easy Work</th>
<th>Moderate Work</th>
<th>Hard Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (green)</td>
<td>70° - 81.9°</td>
<td>NL</td>
<td>NL</td>
<td>40/20 min</td>
</tr>
<tr>
<td>2 (yellow)</td>
<td>82° - 84.9°</td>
<td>⅝</td>
<td>⅝</td>
<td>⅝</td>
</tr>
<tr>
<td>3 (red)</td>
<td>85° - 87.9°</td>
<td>NL</td>
<td>⅝</td>
<td>⅝</td>
</tr>
<tr>
<td>4 (black)</td>
<td>&gt; 90°</td>
<td>⅝</td>
<td>⅝</td>
<td>⅝</td>
</tr>
</tbody>
</table>

* Fluid Intake should not exceed 1.5 qts per hour or 12 qts per day.

Table 2.3: Shows an example of a fluid replacement programme used in the US military, outlining WBGT, work to rest ratios and fluid intake for different intensities of work (U.S. Department of the Army and Airforce, 2003).

Another management and prevention technique besides work to rest ratios, cooling and fluid replacement is that of acclimatisation. This was first introduced in the mining industry by Wyndham and Strydom (1969). They show impressive physiological responses in heart rate, core temperature and sweat rate in workers that have been acclimatised in a climatic chamber compared with untrained, un-acclimatised workers (Wyndham & Strydom, 1969). Their results indicate that acclimatised workers would lead to more productive shift work and less man power needed in the mines (Wyndham & Strydom, 1969). The most effective acclimatisation protocol was in the climatic chamber when compared to underground and laboratory acclimatisation (Wyndham & Strydom, 1969). A more recent review also discussed the effectiveness of three types of acclimatisation; passive heat acclimatisation, exercise induced heat adaptation and a combination of the two, with the most effective being the combined approach (Taylor, 2006). They discuss that by assisting the body to cope in hot working conditions through acclimatisation it helps redistribute sweat secretion and increase plasma volume and compare this technique to that of lowering the temperature (Taylor, 2006). Although it has been proven beneficial, it is not without limitations as is dependent on the capacity of the individual to elevate body temperature and hold it there for extended time periods. It also has not yet been proven beneficial to those wearing encapsulating garments due to the microclimate it exposes them to (Taylor, 2006). Other reviews have highlighted important management techniques that align with the ILO guidelines such as: having workers under supervision; specific health and safety...
procedures; air conditioning units; or ventilation and access to available sufficient drinking water (Cheung et al., 2010; Jay & Kenny, 2010; Keim et al., 2002; Kenefick & Sawka, 2007; Tanaka, 2007; Taylor, 2006).

2.9 Summary

Heat related health consequences include heat related illnesses, decreased physical and cognitive performance, dehydration, productivity and over the long term, potential impacts on kidney function. WBGT is highlighted to be the best method of measuring the thermal environment in any occupational setting, due to the recommendations for a given WBGT and it being used by many people, therefore results can be compared between occupations. Measuring the environmental variable using WBGT leaves only the physiological (rectal temperature, sweat rate) and behavioural (clothing, drinking, activity level) variables to measure. Once the exposure to heat is known there needs to be consideration of management and prevention techniques to include, work to rest ratios, cooling, and hydration programmes when looking to minimise the health consequences. To assess what occupations may need further investigation of this kind, well conducted qualitative research is needed to assess the experiences and perceptions occupational heat in different work places. The gap in the qualitative literature of this kind is evident, even more so with regards to research in the shearing industry, in the terms of qualitative research and any guidelines around occupational heat exposure. This highlights the need for the current research and has guided the research aims and objectives. The aim of this current research is to explore sheep shearer’s experiences of heat in the sheep shearing industry. The specific research questions driving this thesis are:

1. What are the sheep shearer’s experiences of heat in the shearing industry?
2. How is heat perceived in the shearing industry?
3. How do workers respond to occupational heat exposure?

In the following chapter an introduction to the sheep shearing industry, will set the scene including information on, why shearers are exposed to occupational heat, it will discuss the New Zealand climate, the projected changes due to climate change and the impact this may have on workers as a vulnerable population to the health effects of heat.
Chapter Three: Setting the Scene

This chapter will give an overview of both the New Zealand climate and the New Zealand Sheep Shearing Industry, projected climate change and the projected impact it is to have on New Zealand will be discussed. It is important to have an overview of both the New Zealand climate and the shearing industry to understand how they may interact also to outline why it is a good topic for the current research.

3.0 New Zealand Climate

New Zealand is considered to have a complex temperate climate varying from warm subtropical temperatures in the far north to cooler temperatures in the south. It is lucky enough to have a mountainous range dividing the country and leading to several different climate regions within one country. The hottest months are usually January and February and the coldest is July, there are small variations in average summer and winter temperatures, with the mean annual temperature range being 10 °C - 16 °C. Map one highlights the varied climate regions and the impact this has on temperature throughout the country by showing annual temperature from 1971-2000.

![New Zealand Mean Annual Temperature (°C), 1971 - 2000](image)

**Figure 3.1:** Shows the mean annual temperature in New Zealand between 1972 and 2000 (National Institute of Water and Atmospheric Research (NIWA), 2003).
Annual sunshine hours for New Zealand sit at around 2000 hours per year with rainfall ranging 600-1600mm a year depending on climate region (National Institute of Water and Atmospheric Research (NIWA), 2003).

3.1 New Zealand Climate Change

There is unequivocal evidence that climate change is happening and that we as humans are the cause of the majority of this (IPCC, 2007). Some areas in the world will be more affected than others however climate change is a global phenomenon.

Changes in global climate have been documented by the Intergovernmental Panel on Climate Change (IPCC, 2007). New Zealand is already experiencing impacts from regional climate change (IPCC, 2007). There are uncertainties in the amount of overall change that is projected, but there is high confidence that there is going to be an increase in heat throughout the country (IPCC, 2007). Other changes that occur with the changing climate and increased temperature include increased stress on water supply, changed natural ecosystems, reduced seasonal snow cover, glacier shrinkage, sea level rising, coastal flooding and an increase frequency and intensity of extreme weather (Githeko & Woodward, 2003; IPCC, 2007; Reisinger, Nottage, & Lawrence, 2011). All changes related to the climate are important as all have health consequences down the causal pathway however the most important in relation to this research is the increase in heat exposure. Since 1950 a warming in New Zealand of 0.4 to 0.7°C has already occurred, with projected changes to be 0.1 to 1.4°C by 2030s and 0.2 to 4.0°C by the 2080s (IPCC, 2007). Due to the different climate regions in New Zealand it is projected that the Eastern North region will have the largest increase with Western South Island projected to have the smallest increase in temperature.
Figure 3.2: Shows the projected annual mean temperature in New Zealand between 1980-1999 and 2030-2049 (National Institute of Water and Atmospheric Research (NIWA), 2003).

There is projected to be an increase of 5-70 days when the maximum temperature is over 30°C (Mullan, Wratt, & Renwick, 2001). This would have major implications for vulnerable groups such as the elderly, chronically ill, pregnant women, babies and children and, of importance to this research, workers. One of the most significant health implications for New Zealand is an increase in heat related mortality, with a 1°C increase above 21.5°C associated with a 1.3% increase in all mortality (Githeko & Woodward, 2003; IPCC, 2007).

In relation to occupational heat, an increase in days when the temperatures are over 30°C could lead to a significant increase in heat related illness, injuries and accidents in the workplace. The impact is likely to be seen in outdoor, physically active industries such as forestry, agriculture and fisheries. In these sectors in 2010, 31108 workplace related injuries occurred - that’s 15% of all occupational injuries in New Zealand that year (Accident Compensation Corporation, 2012). An increase in heat
exposure could potentially lead to an increase in work related injuries due to the loss of concentration and fatigue associated with heat exposure. One industry that may be exposed to increased injuries from increased heat exposure is the sheep shearing industry, this is due to the physical nature of the job, the seasonal aspect and also the working environment in which the workers are exposed to. The next section will introduce the industry and how it works.

3.2 New Zealand Shearing Industry

The New Zealand Shearing Industry is a well-known one and when people think of New Zealand they often think of sheep. This industry is important to New Zealand as it contributes hugely to exports for the New Zealand economy. In 2010 total wool exports alone brought in $739 million dollars, increasing in 2011 to $908 million (Statistics New Zealand, 2011b). This is a two percent contribution to overall exports in the agriculture and forestry industry. As shearing sheep also has a role to play in the health of breeding sheep for meat there is a contribution to the total meat exports as well (Statistics New Zealand, 2011b). Therefore, the shearing industry helps to earn $2910 million dollars of lamb and mutton exported in 2011 (Statistics New Zealand, 2011b). This doesn’t take into account the total contributions to the national economy but give an idea of the importance the shearing industry has to New Zealand. The main purpose of the industry as a whole is the “efficient removal, processing and packaging of wool from the sheep’s back, transforming it to a saleable commodity” (Pullin & Tipples, 2006, p. 1).

Pullin, 2008 identifies that there has been little research on the labour force within the NZ shearing industry especially data on the ‘people’ from the shearing labour force. The industry is made up of many workers including shearers, wool handlers, wool pressers, shearing contractors and affiliated associations such as rural educational facilities. The New Zealand Sheep Shearing Industry currently includes 5500 shearers in about 300 business units (Statistics New Zealand, 2011a). The everyday shearing (wool harvesting) is down to the shearers, wool handlers and pressers. Shearers remove the wool from the sheep, wool handlers organise the wool with regards to its quality and where it has come from on the sheep. The wool presser then organises the wool into bales for the farmer and the wool buyer to buy and sell on. A typical day for the workers in this industry starts at 7.30 am and consists of four, two hour ‘runs’ (eight hours in total). After each ‘run’ there is a break of half an hour at 9.30am and 3.00pm with an hour at lunch typically at 12.00pm.

Modern day shearing involves catching the sheep in the pen, dragging it to the stand and holding the sheep between the shearer’s legs whilst removing the wool from the sheep with a hand piece (electrical machine). Sheep shearers are paid on a per piece rate, usually being paid for every 100
sheep shorn (Pullin & Tipples, 2006). Their pay is therefore dependant on their work rate, which is
determined by their skill level and ability as well as working conditions. It is up to the shearer to tally
their own sheep shorn for the day and let the contractor know how many sheep they have shorn. Top
shearers are called ‘gun’ shearers and can tally at least 400 sheep per day (Pullin & Tipples, 2006).
Before machines were introduced the only way to remove wool from the sheep was with blades with
top shearers tallying around 180 sheep per day. This shows the advances that technologies have
brought to the industry (Pullin & Tipples, 2006).

Shearers are employed by shearing contractors and it is their job to organise with the farmers when
and where the work is. This organisation is usually called a shearing gang and includes a certain
number of shearers, wool handlers and pressers needed to complete the job, the gang can also consist
of a cook if the location is remote enough (Pullin & Tipples, 2006). The wool harvesting takes place in a
shearing shed on the farm of which the sheep are owned. In New Zealand there are purpose built
shearing sheds on each farm with the size of the shed determining the size of the gang needed.
Shearing is a highly skilled profession requiring long hours of work in harsh conditions (Pullin &
Tipples, 2006). The physical nature of the job demands peak fitness and a lack of stamina can rule
people out of the industry early in their career. The availability of work depends on variables of
weather, availability of sheep, timing, skill level and the team requirement of the contractor (Pullin &
Tipples, 2006).

Within New Zealand there is a seasonal pattern of shearing with two quiet periods throughout the
year depending on the region in which you live. The busiest periods although loosely defined, in the
North Island are mid-November slowing down in mid-February. The South Island is similar but their
main shear starts in December as their pre-lamb shear is their busiest time in September. This is also
dependant on weather conditions as you cannot shear wet sheep: when it is raining the contractor
cannot supply work for shearers. However, the management of work is helped by a good relationship
with the farmers with them helping to maximise shearing days by holding sheep under cover in the
woolsheds (Pullin & Tipples, 2006) The farmer has to be clever with their stock to be able to do this as
the sheep can only stay undercover or indoors for a limited amount of time (Pullin & Tipples, 2006).
Due to the seasonality of the job it is viewed as a very nomadic occupation with workers migrating to
where the work is at that time (Pullin & Tipples, 2006). This leaves the industry often very reliant on
casual employees during peak seasons. Due to the seasonal nature of shearing it is important to look
at the climate that the workers are exposed to in their peak seasons. Shearer’s peak seasons are
dependent on the weather and therefore climate due to the inability to shear wet sheep. This
highlights why the shearing industry is an effective one to explore experiences of heat as is also a high
physically active job. To look at what is already in place the next section will discuss the regulations and guidelines in New Zealand with regards to occupational heat.

### 3.3 New Zealand Heat Guidelines

Currently, there is no regulation of working conditions with regards to heat in New Zealand in any industry, only guidelines by which employers are recommended to adhere to. Although, if not adhered to, it does seem that the consequences of heat exposure including symptoms and injuries are dealt with on a level which identifies heat as a hazard. The documents which govern temperature in workplaces are the Health and Safety in Employment Act (HSEA) 1992 and Health and Safety in Employment Relations (HSER) both of which highlight the importance of identifying occupational heat as a hazard and give advice on effective measures to manage the hazard of heat. Effective management of heat as a hazard presumes that each workplace has the facilities it is required to have by law. An example from the HSER is the drinking water facilities; Clause 8 ‘Duty in respect of drinking water’ states that,

- “Every employer shall take all practicable steps to ensure-
  - that drinking water is provided for employees at every place of work under the control of that employer; and
  - that any such drinking water is wholesome; and
  - that the amount of any such drinking water is sufficient, having regard to the number of employees in the place of work and the nature of the place of work; and
  - that all employees have access to any such drinking water in a way that is convenient to them”

(Health and Safety in Employment Relations 1995)

It also outlines that all workplaces should have access to toilet facilities and ventilation, alongside effective controls of humidity and the atmospheric conditions (including radiant heat, temperature and air velocity).

In the shearing industry at the moment there is one document focussed on the health and safety of the shearing industry, ‘Best Practice Guidelines in the New Zealand Shearing Industry’ (N.Z. Department of Labour, 1998). A section within this paper documents the general risks of working in a hot environment and the importance of practical steps to reduce these risks. Not surprisingly, as the
document is governed by the NZ shearing Health & Safety committee (N.Z. Department of Labour, 1998).

“Improving the design of new sheds and improving the ventilation, insulation and shade of existing sheds will help to reduce the effects of heat on the shearing team. Installation of vents on the shed roof helps to increase ventilation and air movement. The addition of windows that open and close adjacent to the work areas and on opposite sides of the shed helps to increase ventilation”

(N.Z. Department of Labour, 1998).

As outlined in the title of the document these are only best practice guidelines which have no legal standing. However they recognise that making these changes in the working environment would have huge implications on shearsers and other workers experiences of occupational heat and health related symptoms in the shearing shed. Another related document is ‘Wool harvesting. Preventing and managing discomfort, pain and injury’ (Accident Compensation Corporation, 2011). This document recognises that the unpredictable shed environments and variable weather conditions may cause discomfort, injury and pain to those working in wool harvesting (Accident Compensation Corporation, 2011). However heat is not recognised within these documents as a significant hazard highlighting the lack of guidance and legislation around occupational heat in any workplace and in particular the shearing shed due to the amount of variables that contribute to heat exposure in the workplace. The Department of Labour (DOL) and Occupational Safety and Health (OSH) recognise the many variables contributing to heat as they recommend ways to modify them when treating heat as a hazard. They also outline that it is the employers responsibility to work out practical solutions to preventing situations of thermal discomfort, heat exhaustion, fainting or fatal heat stroke (N.Z. Department of Labour, 1997).

3.4 Summary

This chapter has given an insight into the background of the current research. Firstly it introduced the New Zealand climate and the reason behind why heat poses a potential health risk to all physically active workers. Following this the New Zealand Sheep Shearing Industry was discussed to introduce components of the industry and give a background to the workers from which the study population was chosen. With the peak of the shearing season being the hottest months in New Zealand and their ability to work determined by the weather there is a fitting link between shearsers work and the climate. This is especially important to remember in the face of a changing future climate. The current heat regulations and guidelines were introduced and discussed with regards to governing
temperatures in workplaces. It is important to understand this background information to get a picture of why the current research is important.
Chapter Four: Methodology & Methods

This chapter outlines the theoretical framework behind the current research which is an important start to a creditable qualitative research process. A theoretical framework is the explanation behind why, as a researcher I think like I do and view the world like I do and what assumptions I as the researcher bring to the research. This includes assumptions on reality, the construction of knowledge and how they shape the research question, methodologies and the interpretation of the findings (Crotty, 1998). The first aim of this chapter is to describe my theoretical framework, to introduce the research process and look at how they may implicitly or explicitly influence this research (Dew, 2007). The second aim is to describe, in depth, the research methods, including the data collection; ethical approval, sampling, interviews, and data analysis, including how thematic analysis was chosen and used in the current research.

4.0 Research Aims

The aim of this research is to explore sheep shearer’s experiences of heat in the sheep shearing industry. The research questions are informed by the previous chapters outlining the gap in the current literature and the importance of the shearing industry to New Zealand. The specific research questions driving this thesis are:

1. What are sheep shearer’s experiences of heat in the shearing industry?
2. How is heat perceived in the shearing industry?
3. How do workers respond to occupational heat exposure?

These questions are designed to help me gain an understanding of the shearing industry from an outsider’s perspective. I will use thematic analysis of in-depth interviews, from a constructivist perspective, to answer the above research questions.

4.1 Why I chose a Qualitative Approach?

Qualitative methods were chosen to study the phenomenon of heat as I thought that they would be a good way to explore shearer’s experiences (Lincoln, 1992). Also, as outlined in the previous chapter, there is lack of research on the qualitative perceptions of heat in the literature on shearing and heat stress. Researching this issue as an ‘outsider’ helps to gain an insight into the how workers behaviour is changed when they are exposed to excess heat in the workplace. Qualitative research gives me the flexibility to allow things to change through the research process and the qualitative approach is more suited to answering an exploratory question. This is important to when there is not a lot known about
the topic as this has allowed me to explore the concept of heat in a more in depth and explorative manner than a quantitative approach.

Critics of qualitative research argue that qualitative research lacks appropriate methods for data collection and analysis, and some argue that there is no real consensus around what qualitative research actually is (Broom & Willis, 2007). However, if a researcher is explicit about the research process, as I will be, then this critique is questionable. This explicitness includes the theoretical framework the methods of data collection and the analysis. In doing this there will be full transparency within the research increasing validity and credibility in the research process (Sandelowski, 1993).

4.2 The Research Process

Being explicit and transparent about the qualitative research process increases the creditability of the current research. This explicitness includes introducing the theoretical perspectives of the researcher and how this will influence the research. It also includes showing there is an interconnection between all stages of the process. Denzin and Lincoln (2005) outlined five phases to the qualitative research process, I’ll use these to explain and guide what I have done in my research. The first phase is to acknowledge how the researcher shapes the research through their own experiences (Denzin & Lincoln, 2005). This has been addressed by introducing my position as a researcher in relation to the research participants in the preface, and will be discussed more in the section headed ‘Interview’ below. It will also be alluded to in the limitations section of the discussion chapter. Phases two, three, and four of the qualitative research process are the focus of this chapter. They include determining the theoretical paradigms and perspectives of the research, outlining the strategies to answer the specific research questions and describing the methods of data collection and analysis (Denzin & Lincoln, 2005). The fifth phase is the interpretation and presentation of research findings which is the main focus of the results and discussion chapters. Ensuring each phase of the research process is addressed transparently, will increase the validity and credibility of my use of qualitative methods. I will therefore use the rest of this chapter to fulfil phase two and three and identify the theoretical perspectives that have guided the research process and outline the methods used to conduct the research.

4.3 Theoretical Paradigm

Phase two of the research process highlights that it is important to determine the theoretical paradigms and perspectives of the research (Denzin & Lincoln, 2005). To do this it is important to understand what is meant by a theoretical paradigm. I will start by defining a theoretical paradigm then endeavour to make this clearer by introducing the perspectives behind the current research. A
theoretical paradigm includes the philosophical assumptions associated with the research process. It is a philosophical stance or a belief system, on the nature of the world and how we produce knowledge (Broom & Willis, 2007). Denzin & Lincoln (2000) describe it as ‘the net which contains the ontological, epistemological and methodological perspective’. Understanding this belief system or net as it is referred to will help you to appreciate certain decisions that have been made in the research process. It is therefore important for me to introduce my stance on reality and knowledge, to assist in understanding the theoretical paradigms behind the current research (Broom & Willis, 2007). I will do this by introducing the theoretical paradigm of constructivism and discussing the ontological, epistemological and methodological perspectives behind this paradigm. However when reading the following paragraphs it is important to remember that this is only my perspective and belief system on the interaction of reality and knowledge and that the research could have been completed from different perspectives.

4.3.1 Constructivism

As introduced above it is best to describe the constructivist paradigm by introducing the ontological, epistemological and methodological views within it and relate them to my research aims. To recap I am aiming to explore sheep shearer’s experiences of heat in the industry. To do this effectively as an ‘outsider’ it is important for me to acknowledge that peoples’ lives and their understanding of it influence their experiences (Tetley, Grant, & Davies, 2009). This understanding is the basis for the constructivist paradigm and includes the view that knowledge is an ever-changing consequence of human activity and that experiences and realities are socially constructed entities of a wider society (Braun & Clarke, 2006; Guba, 1990).

4.3.2 Ontological Perspective

An ontological perspective answers the question ‘what is the form and nature of reality?’ (Guba & Lincoln, 1994, p. 108). Constructivists believe that “reality” exists (in the social world) only in the context of a construction or mental framework (Guba, 1990). That reality is constructed by people. It is constructed through their life experiences, situations and the context within which they view reality. Guba (1990) describes this view of reality as the ‘key to openness and continuing search for ever more informed and sophisticated constructions’ (p.26). A constructivist perspective recognises that individuals construct their own reality through associated meaning in certain situations (Broom & Willis, 2007). In contrast, a positivist perspective is one that views reality as fixed and that it is there to be discovered. Therefore the constructivist perspective is important for the current research, as the
aim is not to discover one true experience of heat, rather to understand the experiences of heat for the sheep shearers at work.

4.3.3 Epistemological Perspective

The epistemological perspective answers the question ‘what is the nature of the relationship between the knower or would-be knower and what can be known?’ (Guba & Lincoln, 1994, p. 108). This is understanding the relationship of how we, as researchers, come to know what we know about the world (Broom & Willis, 2007). A constructivist uses subjective interactions to access realities, as they view realities to be constructed in the minds of individuals (Guba, 1990). Lincoln (1992) explains the subjective interactions as ‘the inquirer and inquired are merged into a single interactive entity and findings that results from the inquiry are literally created by the interaction between researcher and researched’ (Lincoln, 1992).

In contrast is an objectivist view from within the positivist paradigm. This is where the researcher is detached from the participant, in that the interactions between the two are completely separate entities (Broom & Willis, 2007). This is when the research is of an experimental or manipulative nature within a controlled environment for example, in the successful double blind clinical control trials (Lincoln, 1992). However the objectivist view is not considered for qualitative research as the subjectivist perspective within constructivism encourages interactions between the researcher and participants throughout the process and allows an appreciation of the positive impact this will have on understanding experiences. Recognising this also fulfils the first phase of the research process as outlined by Denzin and Lincoln (2005) in acknowledging the influence the researcher has on the process and also increases the validity of the research (Broom & Willis, 2007). This perspective allows the assumption that knowledge is a human construction and that the subjective interactions (interviews) used to collect the experiences contribute to the overall research (Guba, 1990).

4.3.4 Methodological Perspective

The methodological perspective is shaped by the question, ‘how can the inquirer (would-be knower) go about finding out whatever he or she believes can be known?’ (Guba & Lincoln, 1994, p. 108). This is in reference to the approaches used to collect and analyse data with the constructivist paradigm. Simply put, this is the collection of constructs (experiences of heat) and bringing them to a close consensus, if possible (Guba, 1990). On a practical level for the current research the constructivist methodological perspective for data collection includes the collection of the experiences of heat in the
workplace (constructs), through subjective interactions (interviews) between the researcher and participants. For data analysis the constructivist aims to bring those experiences of heat in the workplace (constructs) to a general consensus (identifying themes).

Having introduced the constructivist paradigm using the ontological, epistemological and methodological perspectives helps to outline the set of beliefs that shape how the current research aims to answer the research questions above. Understanding that I assume reality to be constructed by individuals own situations and experiences and that knowledge is constructed through subjective interactions between the researcher and the participants is important to appreciating the choice of methods used to answer the research questions posed. It is important to emphasize again that this is not the only or the correct way to go about the research it is the way I have chosen. The methods section below offers a complete outline of how the above perspectives influenced the choice of methods in the data collection and data analysis phases of the research, this fulfils the fourth phase of the research process as outlined by Denzin and Lincoln (2005).

**4.4 Methods**

**4.4.1 Data Collection**

**4.4.1.1 Ethics**

Departmental ethical approval from the Department of Public Health, Wellington School of Medicine, University of Otago, was needed for this current research. An application was submitted and approved, briefly outlining the aim of my research, the methods to be used, the participant’s involvement and the confidentiality of the data (see appendix one). Alongside this was the development of an information sheet and consent sheet for potential participants to read and decide whether to be involved, this is shown in appendix two. In the information sheet and consent form it was made clear to participants that they could pull out of the research at any time and if this was the case all information relating to them would be destroyed. Informed consent was gathered from each participant during data collection and confidentiality was a main priority throughout the process. To ensure confidentiality, the names of participants were removed from any of the data pertaining to their participation as soon as the interviews with the participants were conducted. The participants were given numbers for example S1, which represented Shearer one etc. This allowed the data to be stored with no link to the participants and ensuring confidentiality throughout. There was one document that linked the participants to the data and that was a password secured document stored on the computer which only I had access to. All other data was stored on the same computer alongside being backed up on a password secure USB and an online storage account, I was the only
one with passwords to both. This not only ensured confidentiality of the data but also the security as it ensured that the data was backed up in many different places.

4.4.1.2 Sampling

Once ethical approval was given I then started to approach potential participants. As an ‘outsider’ to the industry it seemed to me the logical place to start was the NZ Shearing Contractor’s Association website, which I found through the search engine Google. I joined the mailing list on the website and emailed the president outlining my research and asked for guidance on the best people to contact for potential participants. Alongside this I also attended competitive shearing shows so that people would begin to recognise me and as a way to find potential participants. The shows I attended included; the Shearing World Championships 2012 and Golden Shears 2012 in Masterton, and the NZ Shearing Championships 2012 in Te Kuiti. At these shows I was lucky enough to be introduced to many people in the industry through friends and got contact details of potential participants to approach after the shows. The shows were not an appropriate place to approach interview participants as the shearers competing were focussed on the competition at hand.

Through these two channels; NZ Shearing Contractors Association and the shearing shows I was able to generate a list of people to contact that would potentially like to be involved in the current research. I contacted all those on the list through email. The email included details of my research, what participation would involve, the information sheet, consent form and my contact details. If participants replied this was then followed up with a phone call to organise an interview time and to answer any questions the participants may have had. I also asked them if they could recommend any other participants that may be interested, if they were able to. This sampling method is known as snowball sampling and involves key informants suggesting potential other key informants (Biernacki & Waldorf, 1981). Once I had gained a list of participants I then purposively selected participants to get the best information about the research topic, this is known as purposive sampling. ‘Explicitly selecting interviewees who are likely to generate appropriate and useful data’ (Green & Thorogood, 2009, p. 118). This method of sampling allowed me to choose participants that were information rich in that they were going to be knowledgeable in the industry and were forth coming in their initial contact to tell me their experiences in an interview. This was determined by an initial discussion with the potential participants about the topic and their early thoughts on the research and its process. I also attempted to get a good variety of participants to gain a maximum variation sample. Using this description of my sample meant that I gained maximum variation in variables pertaining to the
participants (Patton, 1990). This included age, sex, currently shearing, ex-shearers, number of years shearing and geographical location of the shearers within New Zealand.

### 4.4.1.3 Participants

The study population consisted of 16 participants, ranging from the age of 19-58. Participants were recruited until it was deemed that saturation of the data (discussed later on) was achieved. All 16 participants, two female and 14 male, currently work in the shearing industry as shearers, either casually, part time or fulltime or were ex-shearers who were contractors, or working for an organisation associated with the industry. Six participants were current shearing contractors, eight were employed by shearing contractors and two were ex-shearers and contractors. Participants were interviewed for this researcher either face to face (12) or over the phone (4). Figure 4.1 below shows the geographical distribution of the participants throughout New Zealand.

![Image of New Zealand map with markers for face to face and phone interviews](image)

**Figure 4.1:** Shows the participant's geographical location and the type of interview completed with the participants.
4.4.1.4 Interview

The choice to collect data for the current research using an interview was due to the explorative nature of the research questions. The other method that was seriously considered was the use of focus groups, but I chose against it due to difficulties in getting participants together in one place. This could have been done at the workplace however as the participants did not own the workplace they may have been more reserved in their responses. Also as a new researcher with only one experience of managing a focus group for research purposes, interviews were more favourable. There was also investigation into completing some quantitative data collection to discuss alongside the interviews. These measurements included heat measurements inside and outside the shed and also productivity numbers of sheep shorn and a correlation of numbers with temperature. It was decided that the quantitative methods could not be included in this current research as the data collection period was outside of the hot season in New Zealand. Other methods of data collection that were considered were questionnaires, and observations both of which would have been viable choices (Broom & Willis, 2007; Patton, 1990). However to fully explore and answer the research questions within the year allocated to the Masters programme, interviews were the chosen method. The chosen method of interviews was beneficial for me as an outsider as it gave the participants the option to openly discuss and explain their experiences of heat.

The flexible nature of the qualitative research design process played a part in the development of the interview guide. It allowed constant evaluation of the data collection process including the data in relation to the research question and my influence as a novice interviewer on the richness of the data. This was imperative to achieving good quality within the research process as it allowed for the adjustment of the data collection methods in response to the data being collected (Broom & Willis, 2007). In the beginning the interviews were completed with a very structured interview, with the final interviews being successful with only an interview guide. The development of the interview guides can be seen in appendix three. This section goes into more depth of how the interviews were developed through a process of reflection and change. But firstly I will discuss my experience as an interviewer and the process of interaction with the participants before, during and after the interview.

As an interviewer I have no experience that I can draw upon for the purposes of this research, I am therefore a complete novice. This is maybe the reason behind why the interview guide went through such a process of change before (as described below) before the final interviews were completed. Although I have no experience in interviews I am good at generating conversations and building a rapport with people I have never met before. This was hugely important throughout the interview stage of data collection as it I believe it allowed participants to feel at ease to share their experiences.
and to be accustomed to having me as the researcher around which adds to the quality of the whole research process (Mays & Pope, 1995). I think the setting for the interviews was also important in making the participants be comfortable to share their experiences; the setting was either in their own home or on over the phone. Choosing to do the interviews at the participant’s house was important for them to be able to speak openly about the topic at hand and also lead them to be accepting of me as a researcher as they had invited me into their homes. The process of the interviews is described below in more detail. Following the interviews I ensured that the participants had a chance to ask any questions regarding the topic, research process and what the data was going to be used for. This left the participants understanding why they had participated alongside how they were going to be kept in the loop. Following the interview the transcriptions of the interview was sent to the participants to check that everything that was discussed was accurate.

The beginning interview guide was from the HOTHAP’s working group researching the impact of occupational heat exposures around the world (Kjellstrom, Gabrysch, et al., 2009). ‘Questionnaire 4: Owner/Operator of a small business or Worker’ was developed by this working group and was available for use by anyone completing research in their subject area (Kjellstrom, Gabrysch, et al., 2009). Being new to qualitative research, this protocol for interviews seemed a logical place for me to begin my research and therefore this was the interview guide for the first seven interviews. This interview according to Kvale’s classification was a ‘very structured’ interview (Kvale, 1996), and after transcribing the first seven interviews I realised that the data I was collecting did not fit with what I was trying to achieve. This interview was very traditional in its methods in that the participant was more of a repository of short answers rather than, a description of experiences a (constructivist view), which is what I was trying to achieve (Hiller & DiLuzio, 2004). The interviews using this very structured guide ranged in length from ten minutes to forty five minutes and lacked any discussion. The constructivist view of an interview is that both the researcher and the participant are mutual in their participation and within this view are producing knowledge through the active interactions of both (Hiller & DiLuzio, 2004). This lead me to re-structured the interview to be more open ended in the hope of generating more discussion around the topic rather than just questions and answers. For example, instead of asking “Is heat exposure a problem at work during the hot season?” I asked “During your work can you describe a situation where you’ve been affected by heat and humidity?” In making these changes I was convinced I had a ‘semi-structured’ interview which was the preferred collection method for the planned thematic analysis (Denzin & Lincoln, 2005; Kvale, 1996). This interview guide was used with six participants and did result in more discussion pertaining to my research questions. However, during the transcription of these interviews I felt there was room for improvement to generate even more discussion, with a focus on the construction of knowledge and to
allow for a richer data set at the end of data collection. This was influenced also by my increasing knowledge on the topic and largely by me reflecting on my skills as an interviewer and reading ‘InterViews’ by (Kvale, 1996). To do this I re-listened to the interviews I had already completed (13) and purely listened to the influence I was having during the interview. This process is also known as reflexivity and it allows an interrogation of one’s influence on the research and allowed me to consciously experience myself as the enquirer and the influence I had on the research process (Mays & Pope, 1995). In doing this I was able to make subtle changes to my interview styles, add to the quality of the research and change the interview guide to generate more conversation. This also allowed me to be more confident in letting the interviews flow more freely and allowing the participants to tell more stories and experiences around the topic, meaning the interviews were more data rich in relation to my research questions. To achieve this I made changes to my interview style, these can be seen in the different interview guides in the appendices. These changes were important to ensure the participants were comfortable enough to share their experiences with me, an outsider to their industry. Changes I made included asking participants to elaborate on aspects of their answers before moving on the next question, this led on to answering many of the questions I had written down without actually asking them. I had a list of prompts to remind me of the research questions.

In the previous interviews I had been guilty of jumping in with the next question and not allowing natural pauses for the participants to think of more information for the questions. This is known as being directive and it is important that new researchers are able to notice this, alongside not jumping in with answers that I had heard previously to see if it was the same (Britten, 1995). To ensure that the participants felt engaged, I repeated back some of their answers and asked for confirmation that I understood what they had just discussed. I also made notes for myself throughout the interviews to return to parts of the story pertaining to the research question without interrupting the participant’s mid-flow.

The third interview guide was used with the final three participants, before it was decided that saturation in my data collection was reached. Data saturation in this instance was deemed to be when nothing new was being introduced to the data corpus, in terms of my research questions (Braun & Clarke, 2006). I began to code the completed interviews whilst conducting the last interviews to ensure that I was clear with when the saturation point was reached. This saturation point was clearer during the final three interviews as they were more data rich with information, in that the participants were able to tell more stories and experiences without being interrupted for the next question. When conducting the interviews, however, the answers were similar to the previous interview guides just in a more story told way and the interviews were not introducing any new information pertaining to the
research questions. Therefore the saturation point was decided after interviewing and transcribing 16 interviews.

I had access to more participants and could have continued interviewing if need be but as no new information was being added to answer the research questions it was not practical to continue. Due to the availability of the participants that had agreed to participate two of the twelve face to face interviews had more than one participant present at the same interview. The first interview had three shearsers present. The final interview had two shearers present. This made no difference to the data that was collected and each participant answered the questions posed to them. All of the interviews were recorded on an audio recorder, stored in a secure file on the computer and were transcribed solely by me.

4.5 Data analysis

4.5.1 Thematic Analysis

Thematic analysis is the chosen method of analysis for the current research. The aim of this section is to introduce to you briefly what thematic analysis is and how it has been used. It is important to remember the theoretical assumptions that have been brought to the research with the constructivist paradigm.

4.5.1.1 What is thematic analysis?

Thematic analysis is a ‘method for identifying, analysing and reporting patterns (themes) within data, it minimally organises and describes a data set in rich detail’ (Braun & Clarke, 2006, p. 79). It is a flexible method, is quick to learn (beneficial to new researchers) and the results are generally accessible to an educated general public (beneficial for the current research due to the study population) (Braun & Clarke, 2006). Often with qualitative research you are required to subscribe implicit theoretical commitments as in methods such as grounded theory or phenomenology (Braun & Clarke, 2006). Using thematic analysis for the current research, allows the analysis to be flexible, although it is underpinned by the theoretical assumptions of constructivism as introduced earlier. It also beneficial for this research due to the ability to generate ‘unanticipated insights, comparing similarities and differences across the data set and offers a in-depth description and analysis of the data set’ (Braun & Clarke, 2006, p. 97).

Using thematic analysis from a constructivist perspective allows an exploration of how experiences and realities operate in society (Braun & Clarke, 2006). It has been used for many different topics in the area of public health in New Zealand including; barriers to promoting of healthy nutrition (Walton,
Waiti, Signal, & Thomson, 2010), Māori experiences of cancer (Walker, Signal, Russell, Smiler, & Tuhiiwai-Ruru, 2008), research on elective surgery (McLeod et al., 2004) and uncertainty in mental health (Dew, Dowell, McLeod, Collings, & Bushnell, 2005) to name a few.

Thematic analysis is a viable option for the current research as it allows for a detailed analysis of peoples experiences which will in turn answer the research questions (Braun & Clarke, 2006). Whilst using this method of analysis it is imperative to be explicit throughout, in particular about the decisions that accompany the methods such as; the type of coding to be used, inductive or deductive and the level of content to analyse whether it is the manifest or latent content. These decisions will be defined, described and discussed the section below.

4.5.1.2 How I used Thematic Analysis

As introduced there was a number of decisions that needed to be made when completing thematic analysis, these decisions were made throughout the process and by no means in any order. The decisions included whether to use inductive or deductive coding and what level of content to analyse. To outline the decisions I chose to analyse my data using thematic analysis with an inductive approach of the manifest and latent content. These aspects of the analysis are introduced below with an integrated discussion of how I used them to follow.

4.6.1.2.1 Inductive coding

Inductive coding is the process of identifying themes from the data set meaning the analysis is data driven (Braun & Clarke, 2006). This way of coding works without trying to fit the data to a pre-existing coding framework and is therefore driven by the content of the interviews and the research questions (Braun & Clarke, 2006). In comparison a deductive approach is completing the analysis with pre-conceived codes and ‘tends to provide a less rich description of the data overall’ (Braun & Clarke, 2006). Deductive coding therefore draws on prior understanding of what is being researched, whereas inductive tries to construct an understanding from the data (Dew, 2007). Inductive coding allows the identification of themes and codes from the data collected in the interviews. This meant that I approached the analysis without pre-conceived ideas of what the data should be telling me. The only reference used throughout the coding process was the research questions to guide the inductive analysis. This type of analysis follows the constructivist perspective in that knowledge, my understanding of the shearer’s experiences of heat at work, was constructed through subjective interactions, the interviews and my later analysis of the transcriptions.

4.6.1.2.2 Level of content
There are two levels of content within an interview, manifest and a latent. The manifest content is what is actually being said and the latent content is the interpretation of what is said (Boyatzis, 1998). The latent content refers to the underlying meaning of what is said in the manifest content (Graneheim & Lundman, 2004). As introduced earlier thematic analysis is a flexible method allowing both levels of content to be analysed (Boyatzis, 1998). In the current research I will code the manifest content during the first coding process, drawing more of a focus to the latent content of the data during the theme generation phase of thematic analysis. This analysis of both levels of data involves an interpretation of the data to allow the development of themes and moves away from a more descriptive analysis which would be more evident when only coding the manifest content (Braun & Clarke, 2006).

4.5.1.3 What I’ve done

As I was new to qualitative research and data analysis I looked for a document which outlined then phases of thematic analysis for me to relate my analysis to. Braun and Clarke (2006) outline thematic analysis in a clear, understandable and structured way which has made it easy to follow, as a first time qualitative researcher. I have used Braun and Clarke (2006) explanation of each stage and have shown how I completed that phase within my own research. It is important to start the thematic analysis process by defining the following concepts:

- Data Corpus: All the interviews and demographic information on the 16 participants
- Data Set: The 16 participant interviews used for coding
- Data Item: One interview alone
- Data Extract: A coded block of data from a participants interview (data item)

Phase 1: ‘Familiarising yourself with your data: Transcribing data (if necessary), reading and rereading the data, noting down initial ideas’ (Braun & Clarke, 2006, p. 87).

To familiarise myself with the data set I transcribed all of the interviews, listening to each data item twice. This was to ensure that the transcription was a true reflection of the interview that was conducted. This process allowed me to understand more about the different levels of content within the data set as on the first transcription I was listening to only what was being said (the manifest content). On the second listen I felt that I was able to understand more about the wider context of the experiences that were being discussed (latent content). This is an example of how the constructivist perspective influenced the early analysis on a practical level as I was able to acknowledge that the experiences of the participants are shaped by wider influences; this also became clearer the more interviews I did. This was the first realisation point in the analysis as I started to understand what
‘immersing yourself in the data’ meant (Boyatzis, 1998; Braun & Clarke, 2006; Denzin & Lincoln, 2005; Graneheim & Lundman, 2004). I felt after the second listen of the data set I was in a good position to start looking for codes.

Phase 2: ‘Generating initial codes: Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code’ (Braun & Clarke, 2006, p. 87).

Generating codes at first was daunting as it was difficult to determine what was and wasn’t a codable piece of data. This became clearer as I became more familiar with the data set and the more data items I coded. A codable piece of data was anything that could have related to the research questions whether it was directly or indirectly, other codable pieces of data that weren’t linked to the research question also had their own codes. This coding process translates back into phase one as I was still becoming familiar with the data. I coded the manifest content of each data item on paper and transferred all paper codes into Nvivo9. This is a computer package used within qualitative research to allow efficient data management of the codes and the coding process (QSR International, 2010). Nvivo9 allowed me to code sections of the data items and make hyperlinks to each data item linked to that code. At this point I decided to start a data analysis diary to keep track of all the steps taken in the process. It was interesting that going through the data set a second time (putting the codes from paper to computer); I picked up more codes which left me more comfortable with the coding process. I made sure that the research questions were in sight throughout this process. This was important as there were sections within the data items that didn’t need to be coded, as they did not directly relate to my research questions. When this was the case I coded them into their own code to separate them from the rest of the data extracts. Having generated a first list of codes in Nvivo9 I went back through the codes and began organising them a little more specifically as there were sections of the data set that I had coded very generally. An example of this was coding the data extracts with any mention of water into a code called water. I then went back through this water code and turned it into five tree nodes of water; amount of water consumed, good water, important to coping, lack of supply and taking own water. This made the coding process more specific and allowed me to move on to the next phase, searching for themes.

The next three phases were completed reiteratively; it was a cyclic process of constantly revisiting phases three, four and five until phase six.

Phase 3: ‘Searching for themes: Collating codes into potential themes, gathering all data relevant to each potential theme’ (Braun & Clarke, 2006, p. 87).
Phase 4: ‘Reviewing themes: Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic ‘map’ of the analysis’ (Braun & Clarke, 2006, p. 87).

Phase 5: ‘Defining and naming themes: Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme’ (Braun & Clarke, 2006, p. 87).

Searching for themes proved to be more difficult than coding; I had over 120 codes and nothing but thoughts and the interviews to link them together. This is where I took a step back from the individual data extracts I was coding, to looking at the data set as a whole. This was driven by my supervisor asking the question “So what do you think the data is actually saying?” In answering this question I was able to take this step back and generate five themes that were driven by the existing codes. Being so familiar with the data I was able to tell a story to my supervisor using the codes and the research question as a guide. This allowed me to generate links between the existing codes and pull them together into themes. In doing this five themes were generated through re-telling the story verbally and noting down the main themes from the story. I did not realise until this point how much I had learnt about the topic, my participants and their experiences in relation to the research question. This allowed me to generate five themes which are the final five themes presented in the results chapter. However they did not all begin with the same name, description and context surrounding them; this came from reviewing the themes.

To review the themes to produce the final five, I revisited the codes I had generated in the initial code generation phase. This was to ensure that the themes I had generated from the story telling, although guided by the codes actually reflected what I had generated in the earlier version. It was so important at this point to have my research questions at hand to ensure that the theme generated from the codes answered the questions. At this point it was also important to decide which codes did not fit in either with the themes or the research question. In this case the codes were put into a file called unrelated codes, this file was revisited multiple times to ensure that the codes in this file did not have anything further to add to the themes / story that had already been generated. By reviewing the codes again alongside the themes and the research questions gave me a sense of what I thought the data was telling me was actually right. It introduced how each of the themes interact with each other as when assigning codes to themes there was overlap and interactions that could be seen. I used Nvivo9 to organise the codes into the themes and colour coded the codes as to whether I thought they were in the right place. I also checked this theme generation process with my supervisor to ensure it was agreed where the codes fitted under the themes. Another process to refine the themes and which assisted in the theme generation was the clearly describing codes in a coding manual (Joffe & Yardley,
This coding manual or the codebook links into phase five of the use of thematic analysis and is described by Boyatzis (1998). He refers to a good theme as ‘one that captures the qualitative richness of the phenomenon and is useable in analysis interpretation and presentation of research’ (Boyatzis, 1998). To generate a good theme he outlines five steps to generate codebook,

- A label
- A definition of what the theme concerns (characteristic or issue constituting the theme)
- A description of how and when the theme occurs
- A description of inclusion exclusion criteria of theme
- Examples of positive and negative to eliminate confusion when looking for a theme

(Boyatzis, 1998)

I used the first four steps to generate a code manual for my five themes, and added in one other step which was the relationship the theme had with another. This was not the end of the theme generation process as after writing the code manual I revisited the codes and the themes to ensure they all tied in together. This highlights the cyclic notion of thematic analysis process as outlined by Braun and Clarke (2006), when searching for themes, reviewing them and defining themes for the results. In doing this the themes became clearer on paper and also when moving on into writing and producing the report which is phase six. The results of the whole thematic analysis are shown in the following chapter, Chapter Five: The results, and satisfy phase 6 of thematic analysis.

Phase 6: ‘Producing the report: The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis’ (Braun & Clarke, 2006, p. 87).

During this phase it was important to represent the attitudes and perceptions of the study population and include enough context to be understood by the reader (Green & Thorogood, 2004). There was a need to keep findings in context and to reflect the participant’s experiences in a believable way (Patton, 1999; Whittemore, Chase, & Mandle, 2001). This will increase the validity, reliability and creditability of the results, that in turn improves the quality of the research (Patton, 1999; Whittemore et al., 2001). Following the writing of the results and the discussion it is important to consider potential ways that the research is to be disseminated following completion, the following section discusses this.
4.5.1.4 Dissemination to the shearing community

It was important to consider the dissemination of the results back to the shearing community as part of the ethics of the research. To disseminate the results to the wider shearing community the results will be first and foremost be sent out to the participants in an email as a part of participating in the current research. Due to me being an outsider to the shearing community I approached the Chair of the New Zealand Shearing Industry H&S Committee for suggestions on where to disseminate the current research. It was suggested that a number of networks associated with the committee may be beneficial to try such as; ACC, Ministry of Innovation and Business, Shearingsports NZ, Tectra, Primary Industry ITO and Federated Farmers. Therefore a shortened version of a scientific paper will be written and produced in laymen’s terms for these networks. There was also a suggestion to write an article for the rural media including Straight Furrow and Rural News, to reach the wider shearing and rural communities that could relate to the research.

4.6 Summary

This chapter has described my methodology and methods. I have set out the theoretical frameworks and discussed what assumptions have been brought to the research process because of them. It summarises how my ‘outsider’ position as the research may have influenced the research process and overviews the methods used in the current research process. The following chapter will discuss in detail the results from the process of using thematic analysis as outlined above.
Chapter Five: Results

The results presented in this chapter are a product of the thematic analysis on the participant interviews described in the previous chapter and will be represented as themes. This is phase six of the use of thematic analysis and is where a core variable (theme) is identified and then the surrounding elements around the theme is discussed (Sandelowski, 1998). The themes introduced in this chapter were identified in both the manifest and latent content of the interviews and as introduced previously are products of my position as an ‘outsider’ to the sheep shearing industry. Five themes were identified: shearing culture, lack of control, “we’ll be right”, self regulation and the want for change in the industry. Each theme will be introduced, discussed in terms of the context in which it arose, and then illustrated with quotes from the participant interviews. This will be done with a main storyline in mind that sheep shearers will continue to work no matter what their exposure to heat, due to how they are remunerated for their work. It is explained well by S14, “I have got an obligation to shear as many sheep for the day I possible can I’ve got a family to support I’ve got a mortgage to pay umm the more sheep I shear the sooner I am debt free” (S14). How this remuneration influences shearer’s experiences of occupational heat will be demonstrated in the themes and the interactions between the themes will be discussed in context. Firstly, the results section will introduce sheep shearer’s experiences of occupational heat, before discussing the five themes in depth.

5.0 Exposure to Heat

This description of shearer’s exposures and experiences of heat in the workplace uses the manifest content from the interview. This section will be used to set the scene as to how the five themes influence shearer’s perceptions of how heat is experienced at work. It will begin by introducing the sources of heat in the workplaces, discuss whether they feel it was problematic and if they have suffered from any heat related symptoms in the workplace.

There are many variables shearers were exposed to which influenced their exposure to heat. This included the season, the weather outside, the condition of the woolshed, how hard they were working, even down to the type of sheep being shorn and how many were in the gang. Many shearers insisted that they could not single out one variable that contributed to their heat exposure more than another. And although they knew when it was hot, the main variable contributing to that heat was difficult for them to identify. However, the two variables that were identified on a number of occasions was the heat of the day (the weather) and the woolshed design, in terms of ventilation (S12, S9, S10, S11). One participant outlined them all:
“So there’s the physical work that builds heat, ummm, there’s the heat from the animals inside the shed and the heat of the day - usually the wool sheds are quite poorly insulated, so umm and ventilated, well others can be well ventilated ya know no worries at all but some are quite poorly ventilated, so you get the stuffiness of the animals grouped together inside the shed, plus because most of the work is done going into summer, the heat of the summer day” (S10)

The weather had an overarching influence on the shearer’s exposure to heat with all sixteen participants referring to it throughout their interviews. The seasonal aspect of their job and only being able to shear dry sheep meant that more often than not it was a nice day outside when shearers were at work. Some participants introduced an idea that the exposure of an accumulation of semi hot days was similar to one-off extremely hot day. “Yea the accumulation, that aren’t extremely hot, just endless days of being that hot, umm, is probably the same effect as having a really hot day” (S15). This was discussed in the context of how the workers reacted to the two types of heat and the symptoms that they had suffered and discussed. Another difference in heat identified by the participants was the geographical differences in humidity between the North and South Island of New Zealand. S5, S8 and S16 recognised that the North Island was more humid than the South, with the South providing drier heat which the body reacts to differently. They recognised that the different heat led to different experiences, S8 discussed the impact on sweating “North Island’s definitely a lot more humid than the South Island and a lot of times humidity can be harder on you than the sun ‘cause I suppose it’s making you sweat more”. Extremely hot days, an accumulation of semi hot days, geographical differences and the shed design all influenced how each shearer would react to heat in terms of the symptoms they suffer to how they managed heat at work.

All participants had suffered from the effects of exposure to heat at some stage in their working life in the industry. Their most commonly experienced symptoms were sweating, cramps, thirst, headaches, light headedness, tiredness and dehydration. When asked to explain their experiences of suffering from these symptoms some participants laughed a little as they viewed the symptoms as normal everyday occurrences. S11 describes this well when talking about dehydration

“Ohhh ya know definitely everyone gets it from time to time it’s normal but the day after you didn’t drink enough water or if it’s really hot, so you’re really lethargic and tired the next day and headaches”. (S11)

From a different perspective, S7, S8 and S11 discussed extreme experiences of symptoms such as collapsing and fainting, but often did not attribute these symptoms to the heat. An example of this
was when S10 talked about an experience of death on the shearing board, “I know others that have [suffered from heat in the shed], where people have died on the board, well, died in the shed from exertion. I’m not saying it’s because of heat or anything but heart attacks and things so”. While it is not clear the details of this case, exposure to excess heat can contribute to heart attack events due to the excess strain heat imposes on the heart and other organs. This is an example of participants being unable to attribute symptoms to one main contributing variable and also that shearers are willing to continue working even when suffering from heat related symptoms:

“It gets exhausting but because you’ve got your job to do, and ya’know the way I’ve been taught to shear is that you just keep walking into the pen to get your next sheep, but it gets to the stage where it’s your head gets so hot that it feels like your skull is tight and you get a headache, your eyes like your cheeks swell up so it makes your face puffy and you can hardly see out of your eyes, yea and like I say and then you try and keep your chin up cause if you drop your head down too much it puts more pressure on your on your back umm yea it just feels like your head it going to explode” (S15)

The shearers themselves have identified the variables that contribute to their heat exposure but it seems they are unwilling to make the causal link to any health related symptoms from their occupation. It is not that they are unable to make the link between the two; it is because symptoms within the industry have been tolerated due to them having a job to do and if they do not work they do not get paid. This unwillingness to make this link could be due to the majority of the participants having difficulty deciding whether heat in their workplace was problematic or preferential. Each participant when asked if heat was a problem in the workplace agreed (S1-S16). However later in the interview they would describe how they preferred working in the heat rather than the cold. The preferences with regards to working in the heat came down to three things. Firstly, knowing that there is work “I mean like when it’s hot it’s annoying but at least we know that we’ve definitely got work” (S11), as sheep cannot be shorn when they are wet. The second and third reason is explained well by S12 below with other participants agreeing (S13, S9, S5, S10)

“personally I’d sooner have it hot than cold cause in such a physical job your muscles and joints work better than in really cold weather, umm you get more aches and pains in cold weather, if it’s hot everything is working better. The hotter the sheep are the better, they, the more open the wool is, the grease is lifted off the skin and they’re easier shearing definitely so, no, I’d sooner have it hot than cold” (S12)
The combination of knowing you have work, the sheep being easier to shear and your body being more able to move better would lead to higher numbers of sheep being shorn. As shearers are paid per sheep shorn it makes sense for them to prefer the heat as more sheep being shorn leads to more money for them to take home. The problematic side of heat, though every shearer referred to it was more difficult to define. It was more a sense of when heat was tolerable compared with it being detrimental to their work a sort of ‘tipping point’ from manageable to suffering. This ‘tipping point’ was also difficult for shearers to define as they often could not make a link between the heat variables and related symptoms. The health related symptoms were often noticed the next day when time off was required to recover. S16 talked about a time when it was so hot at work that even fans didn’t help with the exposure to heat, “even with the fans it was just moving hot air around anyway and it was the next day that we felt it, the next day we were just shattered it was so hard to work, but we knocked off early”. Other participant’s experiences followed the same pattern in that they would work through their symptoms at work but be in a situation where they are unable to work the next day due to their symptoms (S5, S11, S15).

This pattern of working through symptoms and carrying on the main storyline and underpinned all themes is that shearer’s will work no matter what their exposure to heat was, even at risk to their own health purely because they are paid per sheep that they shear. This hints at a more reactive response to occupational heat within the industry rather than a proactive response. It also shows why and how shearers are able to continue to work without complaint under this heat stress. To further illustrate responsive reaction to occupational heat exposure and the willingness to continue working in unfavourably hot working conditions, four themes will be introduced. Three of these themes, lack of control, “we’ll be right” and self regulation are underpinned by the theme, shearing culture, which is the first theme to be introduced.

5.1 Shearing Culture

The shearing culture theme highlights a stereotype and culture that was evident throughout the interviews and is based on a traditional ‘outsiders’ view of workers in the shearing industry. From this view it is the shearing culture that underpins three of the other themes, and allows an understanding as to why shearers respond in the way that they do to occupational heat exposure.

The shearing industry has often been referred to as having a unique culture and therefore a stereotype, which for some within this industry is perceived negatively and to others, is just how it is. A quote from Te Ara Encyclopaedia of New Zealand describes the traditional stereotype of the shearer; “Early shearers in New Zealand were generally seen as hard-drinking, foul-mouthed
scoundrel” (Williams). S9 outlined his frustration of the ‘outsider’s’ view of the industry referring to this stereotype, “We’re not talking about the big black jack ya’know how some people seem to have that image around shearing and it annoys the hell out of me” (S9). However this stereotype is lived up to in many participant interviews, referring to the drinking when discussing their experiences of occupational heat (S7, S11, S14, S15, S16).

“A lot of the guys also they end up having, ya’know, they might stop and end up having a couple of beers on the way home when it’s really hot, it’s not so much these days but traditionally it’s always been associated with shearing is having beers after work... a lot of farmers when you’ve finished shearing they umm they might buy some beers for the guys for doing a really good job and working through a really hot day” (S11)

Some of the shearsers interviewed were not too happy about how their industry was viewed by outsiders in and portrayed in the media with one participant mentioning a. An example was a news story in The Press with the title ‘Drink culture a shear tragedy’ referring to the drink driving culture surround shearing and it having an impact on the death that had occurred (The Press, 2012). One participant’s response to that news story came out in the interview about work practices: “It’s a bit topical at the moment with shearers and drinking that’s a really interesting one shearers I think shearers don’t actually drink more alcohol than anybody else” (S14). This indicates the perspective from inside the industry that the stereotype being discussed is an outsiders perspective; which also was not helped by the recent airing of a programme titled ‘Shearing Gang’ on Prime (Wilson, 2012). This portrayed workers in the industry as having a ‘work hard play hard’ attitude to life, with an emphasis on ‘play hard’ for entertainment value. This hints again at the traditional stereotype and the shearing culture, “you probably don’t drink enough water before you drink the beer and the beer has come out of the fridge and it’s nice and cold” (S16).

This tradition of having a drink after work is one of the work practices that has not changed within the industry and played a part in the generation of the traditional stereotype. Another tradition that has endured within the industry is the design of the woolshed. This was referred to by S14, S15, S16, S8, S11 when discussing their workplace practices and things that will impact on their exposure and response to occupational heat.

“It’s pretty traditional game what we work in ... conditions haven’t changed haven’t improved either though... the shearing shed is still the same thing we working in the 1950’s, 1960’s, a lot of these sheds that we’re working in were built then I mean some of them are a hundred years old, but, so there’s not a great deal of improvement in that we
[are] certainly not [any] great study on ventilation or umm ya’know or temperature effect inside the shed” (S7).

This emphasizes the idea that shearers have been exposed to unfavourable working conditions for the past 60 years with little change in the industry. The shearers themselves revealed macho and hardworking characteristics throughout the interviews that allowed them to contribute to them being able to tolerate these conditions. S9 highlights them nicely,

“there’s all sorts of different characters and things in the shearing industry and some of them probably most of them would be pretty macho sorta characters and you just toughen up and get on with it rightly or wrongly” (S9).

Another characteristic that emerged throughout the interviews was a competitive one, where shearer’s in their everyday work spoke of the competitive nature of their workplace (S8, S9). These characteristics: macho, hardworking, competitive, may have contributed to the stereotype that shearers have been given from the media, popular culture and outsiders looking in. However these characteristics coupled with the stereotype, very much underpin the nature of how they are able to work in the conditions they do and how they respond to occupational heat. S8 referred to the competitive characteristic being a driving force as to why the industry is so productive, “that’s why shearing is umm so productive cause it is really competitive you’re always trying to beat someone in the shed” (S8). This characteristic may also lead to unfavourable work practices when workers are exposed to occupational heat. This competitive characteristic would allow shearers to push their own limits and is a characteristic that is instilled in shearers from the very beginning at learner level.

“All good shearers have a pretty strong competitive streak in them, I’m not talking about shearing competitions I’m talking about commercial shearing [...] but if it comes down to it and you’re one sheep behind the ‘gun’ [top shearer] in the area you’d do anything to pip him by one and that’s not just for the top end... this is right from day one when you’re shearing if you’ve got that competitive streak in you you’ll be gunning it with your mate next door to I’m going to be the first one to get my first one hundred it’s crazy it brings it out in ya I’d have to say if we weren’t paid per sheep I’d have to question whether you would get very many people wanting to do the job cause that competitive part of you actually keeps you going umm and it’s not really all about the money its ‘bout that status, yea” (S9)

It was unclear as to whether this characteristic was a result of shearers being paid per sheep or whether the industry attracts competitive people. One participant seemed to think that a reason why
people entered the industry was due to how they were paid. The competitive, hard working, macho characteristics and the stereotype portrayed in the media are important to understand when introducing the next three themes. The culture of shearing underpins shearer’s perception of heat and also their response to occupational heat. The younger generation are also beginning to challenge an aspect of this traditional culture and will be discussed in a later theme ‘want for change’.

5.2 Lack of Control

Lack of control is the first theme that emerged from the interviews that has a bearing on the shearer’s experiences of heat. The shearing culture theme underpins these however did not have a direct influence on to shearer’s response to heat. As the name suggests there is a lack of control of some variables within the workplace which positively or negatively influenced shearer’s experiences of heat. These variables include climate, weather, season, market wool prices, market wool prices, number of sheep in an area, weight of sheep, animal presentation, shed design, building materials and access to drinking water. Table 5.1 below sets out examples of how these variables were identified in the interviews and also who has control over these variables. The shearers have very little control over any of the variables. Their experiences of heat are entirely influenced by variables that are out of their control.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Controlled by</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market wool prices</td>
<td>Market</td>
<td>“Oh I mean up here the seasons have got shorter cause people aren’t buying as many store lambs cause we’ve had a few drought years umm but that’s very variable on market if it’s a good season again they might buy more lambs again then our season gets longer cause people buy in more sheep” (S16)</td>
</tr>
<tr>
<td>Season length</td>
<td>Farmer</td>
<td></td>
</tr>
<tr>
<td>Number of sheep</td>
<td>Farmer</td>
<td>“Certainly the droughts - a lot of my clients would have had through the droughts about 10% less ewes so there’s a lot less sheep [...]the fluctuating sheep numbers have a bit of an impact on the shearers but it’s a it’s a, yea, the shearing patterns have definitely changed” (S14)</td>
</tr>
<tr>
<td>Climate</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Number of sheep</td>
<td>Farmer</td>
<td>“And that’s in terms of what sort of animal you’re shearing if they’ve just been run in out of the paddock and they’re hot if they’ve been squashed up in the pens out the back and they’re hot I mean that’s a huge amount of heat coming off a big woolly animal” (S9)</td>
</tr>
<tr>
<td>Animal presentation</td>
<td>Farmer</td>
<td></td>
</tr>
<tr>
<td>Weight of sheep</td>
<td>Farmer</td>
<td>“umm the weight varies but some of the sheep are quite heavy and come up to 60-70kgs and to shear the sheep to take the wool off umm most of that job involves bending over” (S11)</td>
</tr>
</tbody>
</table>
| Weather                   | -             | “so umm and most of the time like we’ve had a really hot summer at
the moment and ya’know the temperature well the outside temperature I suppose has been around 31 32 at the best so... but we haven’t had anybody knocking off ya’know knocking off this year... yea” (S7)

<table>
<thead>
<tr>
<th>Season length</th>
<th>Farmer</th>
<th>“Your main shear’s generally...your busy times are generally December January February March ummm and then April May and June can be a quiet period and you build up again for pre lamb” (S8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shed design</td>
<td>Farmer</td>
<td>“some of the sheds are low roofed cause they’re old...they’re really old buildings so ummm air ventilation is a problem n the oxygen levels in the shed gets quite depleted ya know like there’s sometimes ten staff and then you could have five or six hundred sheep in the same area creating heat and using the oxygen levels which affects umm muscle cramps and all that sort of thing” (S6)</td>
</tr>
</tbody>
</table>
| Building materials | Farmer | “any clear light above your head it just lets the sun bake onto the back of your head like shearing outside” (S15)

“just coz of skylight up there like after lunch man you could just feel it beating down aye... it was unreal. “(S2)

| Access to water | Farmer | “our employees often haven’t got access to good water... it’s umm a bit marginal out there a lot of water around the shearing shed is often off the roof ...and held in tanks for long periods ya’know without being drained out or whatever so you can get the odd foreign object on the roof or like ya’know rodents and things so ya’know yea it’s pretty hard to police because we don’t own the workplaces we only work at them” (S7) |

**Table 5.1:** Shows the participants recollection of what variables influence their experiences of occupational heat exposure and identifies who has control over them.

Sheep shearers are employed by shearing contractors, and shear sheep in a woolshed that is owned by the farmer who also owns the sheep. This means that the working environment for shearers is ever changing. With the farmers having an influential role in how the shearers experience occupational heat. Every participant interviewed noted that the working environment (shed design, building materials and access to water) has the biggest influence on their experiences of heat (S1-S16).

As introduced earlier in Chapter Two it is the environmental variables that determine how well the body is able to exchange heat and therefore thermo regulate. Wool sheds are often built out of tin.
Tin heats up and allows heat to transfer through it which exposes the workers to radiant heat from the sun outside. Another material discussed in the interviews was the use of skylight (clear plastic) in the roofs which posed the same problem. This would make the job similar to shearing outdoors as they do in other countries but defeats the object of having a purpose built shearing shed. This exposure to radiant heat alongside the high humidity in the shed due to the lack of ventilation and air movement makes heat loss through evaporation difficult. One participant highlighted the issue of ventilation in the sheds;

“umm the ventilation is a big issue and once again the style of the shed has an emphasis on the natural ventilation umm not a lot of sheds have actually got it. I mean the ventilation is probably by accident rather than on purpose umm ya’know the door to bring the sheep in out the back, the door to come in or to load the wool out” (S9)

This was also recognised by others (S10, S1, S2, S6). Access to water in the shed was also one of the most commonly identified variables out of the shearers control that influenced workers ability to respond to heat. All shearers at some point in their interview remembered a time where they or a colleague was ill due to drinking the water available in the shearing sheds.

“You can’t trust the shed and what’d you do? You get to the shed and the waters rotten ohhh ya know tell the farmer ‘ohhh we need some clean drinking water’ ohh grump and moan - some of them are really good they’ll go find you but others, ppfttt” (S14)

The main health implication of the lack of access to water especially in such a physical occupation is dehydration. This is even more apparent on hotter days when the body’s thermoregulation system is already trying to maintain thermal equilibrium.

The examples of the control of the working environment show the extent of the lack of control shearer’s have in their workplace and therefore their experiences of heat. One participant recognised this influential role that the farmer has on himself as a shearer and also his employee’s (as a contractor). S6 introduced the need for the farmers to be educated on the health impacts of their working environment has on the shearers.

“I think more important is the education of our shearers ya’know and even to the farmers to a certain extent. Ya’know like they don’t value …it’s not that they don’t value the work, I don’t think they realise the impact of that one or two days that we’re doing in their shed. They just think ‘oh it’s only a couple of days they can put up with it they’ll be right’ but they don’t realise you’ve been doing it for seven weeks and ya’know sometimes that one or two days in that small shed that they’ve got, with not very good water quality and the
air is the way it is, is sometimes what tips them over and yea we do get the work done but the injuries come later on if not that day and they don’t see it” (S6)

Other participant’s recognised the influence of the working environment but outlined the lack of control that “there is not actually a lot we can do” (S5, S9, S10, S11, S14, S12, S16), showing the lack of control. Many realised that changing the working environment would come at a large cost to the farmers and are therefore willing to continue working in conditions that may put them at risk of health implications from the heat exposure.

“To change woolsheds is [a] large capital expenditure for the farmers and they’re just not going to do it... unless they build new woolsheds and that’s sort of a thing they do once every three or four generations on the farm they might have to build a new woolshed so... and then there’s not a great deal you can do to change them” (S5)

This lack of control within the working environment may have contributed to the tolerance of symptoms relating to the exposure of occupational heat as introduced earlier. It affects how they perceive heat to affect their work and also their ability to respond to occupational heat when exposed to it in excess. This again, illuminates that the remuneration shearer’s receive for their work gives them an extrinsic motivation to continue working no matter what their exposure to heat. This in turn has led to the “we’ll be right” attitude of which they approach their work, accepting the lack of control over the working conditions. Shearer’s are able to have this attitude to their work as they are able to self regulate certain behaviours to continue working. The “we’ll be right” and self regulation themes are closely interlinked are the next themes to be discussed.

5.3 “We’ll be right”

The lack of control that was evident in the shearer’s experiences of heat in the workplace was mainly dealt with by their “we’ll be right” attitude. This is very closely linked with the theme of self regulation which will be introduced in the following section. Underpinning all the themes is the macho, hard-working stereotype alluded to in the shearing culture discussion. It is useful to introduce the “we’ll be right” theme by explaining what the statement “we’ll be right” means, and where it comes from. There isn’t a better way to do this than by reading the lyrics in two verses of a 1950’s New Zealand folksong written about hard working New Zealand men (hunters and forestry workers).

“When you’re huntin’ in the mountains and your dogs put up a chase,
And this porker’s comin’ at you and he doesn’t like your face
And you’re runnin’, and he’s runnin’, and he’s crowdin’ on the pace,
Well don't worry mate, she'll be right,
She'll be right, mate, she'll be right.
Don't worry mate, she'll be right.
You c'n get y' feed of pork when he slows down to a walk,
So(And) don't worry mate, she'll be right.

Now you're loggin' on the saddle and you're drivin' down the bluff
With a thousand feet of timber bouncin' right behind your chuff,
And the clutch has started slippin', and the brakes are worse than rough,
Well don't worry mate, she'll be right. She'll be right mate...
Give 'er all you can give 'er, she'll just fly into the river,
So don't worry mate, she'll be right.”

‘She’ll be right’ by Peter Cape in 1955, (Archer, 2012)

“We’ll be right” [or she’ll be right] is still a commonly used saying in New Zealand society and reflects the attitude of many New Zealanders that ‘no matter what, we will be alright and that nothing is a hassle’. The verses above also reiterate how this theme is underpinned by the shearing culture and the traditional stereotype of shearer’s as introduced earlier on. This seems to be a very prominent attitude when discussing working conditions and occupational heat exposures of shearers. With one participant using a derivative of it in an interview, “ya’know our guys they just keep on going to work we’ve got an old attitude of ya’know harden up ya’know you’ll be right we’ll get through it and you do” (S6). The shearers learning to tolerate heat related symptoms illustrates this “we’ll be right” attitude as they accept these symptoms as a part of their job, due to the lack of control over so many variables. It was often referred to in the interviews as the ‘nature of the job’ (S5, S6 & S12), and that it was the same for shearers anywhere. “That’s just sheep shearing that’s the same for everyone it doesn’t matter where you go it’s the same shearers all around the world you deal with the same issues” (S14). Indicating, once more, that the culture within the industry, no matter where you are, underpins work practices, experiences and responses in the workplace. With regards to heat, participants have become accustomed to it, “Yea hey you get accustomed to it... it can be hot and horrible but you just adjust to it” (S9). And almost seems that shearer’s are willing to pay a price with their health as at the time of exposure their focus is to shear sheep, the more sheep they shear the more they earn. One participant recognised that an outsider to the industry may see the “we’ll be right” attitude as having an unfavourable impact on work practices but is considered the ‘nature of the beast’ for people in the industry.
“ya’know we’ll be right we’ll get through it and you do but ya’know you pay a price somewhere for it you just get out there and get it done and I know it doesn’t ...it’s not what people want to hear but that’s the truth of it and we’re not happy about it but that’s just the nature of the beast and until we can change that but I’m not sure how to change it it’ll continue to be that way and I mean we do our best” (S6).

The “we’ll be right” attitude lends itself to workplace practices that may be unsafe but the culture and traditional stereotype in the industry leads to the symptoms of heat be tolerated to a high level. Only five participants could recall a time when themselves or their work mates had to cease work completely due to the heat (S2, S7, S14, S15, S16). This reflects the strong “we’ll be right” attitude to continuation of work as all participants had suffered from heat related symptoms. This we’ll be right attitude, couple with the extrinsic motivation of being paid per sheep has led the workers to tolerate symptoms and continue working in potential health threatening situations. “Usually you just say ohhh bloody hell and just knuckle down and get it done (S11).

This attitude of the workers is potentially a reason why the industry is so untouched in terms of regulations, guidelines and policies. The attitude lends itself to one that doesn’t complain and fits well within the shearing culture and traditional stereotype introduced earlier. It may therefore be the reason there have been little changes in working environments in the industry over the last sixty years. Instead, shearers attempt to self-regulate behaviour, in order to continue working in unfavourable conditions especially when exposed to heat.

5.4 Self Regulation

Self regulation in this context refers to the shearer’s ability to regulate their behaviour to allow them to work in unfavourable conditions. This is driven by the “we’ll be right” attitude, the lack of control they experience in most areas of their workplace and is shaped by the shearing culture. Shearers have adopted behaviours and workplace practices that are indicative of self regulation when exposed to heat at work. These include, carrying fans, resting, self pacing and carrying their own water.

“It can be hot and horrible but you just adjust to it by what you wear and ya’know whether you open that window or whether you have a fan you just work with the environment and make it I mean I guess there are rare occasions where you actually have to ease off and not have the pedal down quite so hard” (S9)

All participants talked about coping with exposure to excessive occupational heat through hydration (S1-S16). One participant highlighted how important it was to him,
“as long as you’re getting plenty of fluids that’s the most important thing and I learnt years ago the equation... that if you lose 10% of your body fluid you lose something like 40-50% of your strength or ability to work... umm I would think that’s the most important thing if you’ve got your body fluids up it’s amazing what you can do” (S12).

As introduced earlier, access to water was one of the main variables that the shearer’s have no control of in the working environment. As a result, most shearers took their own water to work, to allow them to deal with hot working conditions. A concern from the workers (S9, S6, S2, S3, S5, S6, S9, S11, S13, S14, S15, S16) was that when it was hot they felt unable to drink enough water for the amount that they need, due to the lack of the available drinking water in the shed.

“ummm the bottom line is really when your, when it is really really hot and you are sweating you don’t seem to be able to shove enough in for what’s going out and you seem to be in a state of depletion most of the time and that effects your thinking and your performance to a level” (S6)

This often left the workers in a constant state of depletion (dehydration) and them never being able to catch up when it was hot. S3 talked about after work hydration,

“ummm the thing is when you stop working you stop drinking water... as soon as I get home I home I might have a couple of beers but I won’t sit there and guzzle 10 litres of water at night and I wake up in the morning feeling prrrft ... average” (S3).

This then has health implications of being in a constant state of depletion with regards to water. It can have physical and cognitive effects on an individual’s ability to thermo regulate and in turn be productive at work. The pressure of carrying enough water to the sheds also impacted on shearers drinking habits as they always have in their back of their mind that they may not have enough for the rest of the day.

“cause you need probably during the peak of summer probably drinking eight litres a day sorta thing umm yea so you’ve got to carry a fair bit with you there’s not a lot of sheds that have their own drinking water supplies with them round here” (S6)

This illustrates that although shearer’s have the knowledge about drinking enough water as a mechanism to cope with heat. But maybe find it harder to put into practice, especially where the working environment and culture does not support this. The amount of water being drank was also influenced by the body position you’re in when shearing (S10, S16) and not wanting to frequently take breaks to go to the toilet due to losing pay (S9). The lack of access to water also limited the ability to
cope with heat through washing (cooling) to cool down in the breaks. S9 and S14 talked how effective washing was in the breaks as did S16, “getting as much water running over your veins and stuff on your hands umm is a way to try and cool down” (S16). This also provided relief for the shearers to get rid of the salt left on their skin from sweating so much in the heat. Many discussed changing clothes in their breaks to prevent getting a chill (S5, S8, S9, S10, S14, S16).

Another self regulating method used to manage in response to heat was taking a fan to work. This addressed the issue of poor ventilation in the sheds. All participants discussed using this method to manage heat in the workplace a normal practice, “most of the guys carry fans... no all of the guys carry fans round with them now” (S5). The lack of ventilation seemed an issue for many participants as they highlighted that without a fan “you’ve got to back off you can’t work to your full potential it could cost you” (S8). This is in terms of the amount of sheep being able to be shorn and therefore their pay packets at the end of the day. This introduces the self regulating behaviours of self pacing and rest, which were unfavourable due to the potential loss of earnings from both behaviours. Rest was the option chosen by shearers in their smoko and lunch breaks with one participant outlining how it may look to an outsider, “it probably looks nuts to an outsider you walk into the woolshed they’re all hard wooden floor, they’re all just fast asleep quite happy quite comfy yea so generally lunchtime everyone has a sleep” (S14).

Rather than rest which would lead to a drop in income, shearer’s talked about preferring to self pace their work rate. This allowed shearer’s to continue earning when the heat levels were at the ‘tipping point’ as introduced earlier. Participants described how it was important to know and understand their limits and those of their workmates when working in the heat. To choose an appropriate pace in which they were able to continue working without detriment to their health. “It’s more your work rate umm yea your work rate slows right down there’s no point in busting your gut” (S15). Although at times when they were suffering from symptoms there was still the “we’ll be right” attitude and culture underpinning their ability to continue working, no matter what the heat exposure. S3 discussed that when he gets really hot he will , “Just have a break... yea ten minutes have a rest ... yea and then try and carry on” (S3).

The workers ability to self regulate their behaviour gives them a sense of control over their ability to continue working in unfavourable environments. However it seems this self regulation is met with some barriers due to the lack of control in the working environment and also how they’re remunerated for their work. They therefore self regulate their behaviour to allow them to manage the heat in the workplace; this allows them to earn as much as they are able. However this self regulation gives workers a sense of security that they can work in environments that pose potential health risks.
It seems that self regulating behaviours work to a certain extent in that they allow shearers to tolerate the heat related symptoms. However alone is not enough to regulate and manage the effects of heat in the industry. Throughout the interviews participants often referred to a want for change within the industry, which on some levels challenged the traditional stereotype introduced earlier.

5.5 Want for Change

The want for change as a theme was identified throughout the interviews when discussing the responses to heat. This theme encompasses different kinds of change including the want for change in the working environment in a response to the lack of control. A second aspect of this theme includes descriptions of how the want for change in the industry challenges the traditional stereotype of a shearer. Both aspects are important to understanding shearer’s current responses to occupational heat but also gives insight into how there is potential for change in the industry with regards to shearers experiences of heat in the future. This want for change stems from the “we’ll be right” attitude and self regulation of behaviour as responses to heat. It indicates a thought that the current ways of dealing with heat at work are potentially not enough and that things need to change. This is reflected in accounts in the interviews where shearers discussed their tolerance of heat related symptoms when discussing their experiences of occupational heat.

The want for change within the industry seemed to be driven by the younger generation of participants but was largely observed by the older participants. The younger generation portrayed qualities throughout their interviews that challenged the shearing culture and traditional stereotype, positively reflecting strengths in the shearing culture as a way to make change in the future. These qualities expressed during the interviews were; professionalism (S14, S5), organisation (S7, S14), and needed high physical fitness (S13, S12). Also that they were hard working (S1-S16), they valued and practiced team work (S11, S13, S15) and were educated (S16, S6, S7, S15). These positive qualities represented by the participants indicate how the shearing culture and the traditional stereotype of shearers are disputed within the industry today.

“And that ‘harden up’ used to come into it a fair bit whereas now we’ll sit down and talk about our different problems and how to deal with them whereas in my dad’s era they wouldn’t have talked about their problems cause it’s a sign of softness” (S15)

This challenge to the shearing culture was referred to by other shearers throughout the interviews (S6, S15, S16, S14) with the younger generation being portrayed as more educated than previous generations. This has potentially influenced the mindset and portrayal of the traditional stereotype in
the media and popular culture. Some of the older shearers recognised that things had begun to change in the industry, as will be discussed later in the chapter.

“Well I think the younger generation is actually better educated about umm ya’know in my day like I mean beer was meant to be a thirst quencher ya’know you did a hard day’s work and you fixed it with a bottle of beer that was ... and you now know that’s not the case so younger people are definitely better educated” (S7)

The younger generation were perceived to be better educated and to know more about how to look after them to perform better in the workplace. However, they were also identified as the population that could still do with the most help around how to look after themselves in the workplace. This reiterates the point introduced earlier that having knowledge doesn’t always reflect behaviour change especially in situations where there are barriers - for example, hydration. Shearer’s know that they should drink more water to be able to cope with heat and that they need to self regulate their own behaviour to do this. However there are barriers and a lack of control over the working environment, such as access to water which influence this. Education was called for in both the younger generation of shearer’s (in terms of looking after themselves) and farmers (in terms of improving the working environment) (S7). This would be a step towards making positive changes in the industry for the future around shearer’s experiences of occupational heat (S7).

“I’d like to see the education to the guys to drink more water look after themselves a little bit better and I’d like to see some of the farmers umm look at the design of their shed umm in terms of ventilation and that water quality thing is far more important than they realise” (S6).

Education was introduced earlier when discussing the self regulation of drinking water but is unfortunately not always a solution. Shearer’s know they should be drinking more water on hot days but continually suffer from the health effects of heat such as dehydration because of the barriers faced, like access to drinking water and bathroom facilities. This suggests that education is not the main issue. It does however, highlight the want for change within the industry of elements that shearer’s have no control over. Many participants discussed little changes needed in the shed design to make it a more habitable place to work, like the need for ventilation and access to clean water (S1-S16).

“A good woolshed is well designed and it makes, it takes the stress of the whole team ya know if the shed is well designed there’s a proper toilet, there’s good hand wash facilities, there’s a modern hydraulic electric wool press ,the pens in the back of the shed are well
designed so the gates, the sheep run into the pens easy, all those things good design makes our job so much easier compared to some of the old poorly designed placed, badly designed places that we work in, yea design is everything for sheep shearers everything and that’s just ergonomics isn’t it” (S14)

This want for change was strong throughout all the interviews but many participants still felt they were powerless to make any changes (S5, S6, S13, and S11). Another want for change within the industry that was identified throughout the interviews was the notion of the work life balance and family time with regards to the working hours shearers are expected to do (S11, S9, S5). This reflected a challenge for the shearing culture from the younger generation. The quote below challenges the hard working tradition of working when there is work, every day, all season, when compared with work life balance.

“Interesting because I mean right through till I just found myself doing a shearers meeting down in Milton last week and um having discussions with a bunch of shearers afterwards about ‘should we have the weekends off and just do five days? Or should we just work when the sheep are there to shear, seven days a week?’ The old me from years ago shearing said well if I hadn’t have done the long stints of say 40 days plus shearing without a day off I would never have become as good a shearer as I managed to become, ya know, when you get absolutely stuffed you actually shear better is my history, because you don’t put the physical energy into it, you put technique into it and you learn how to do things the easiest way possible so ya know, we managed all those situations in huge temperatures some times in the summer and you I don’t know how many degrees you add on for a working woolshed but it’s quite a lot… umm. yea and Jit was interesting to see if that group I was talking with last week, were any, were representative of the rest of the industry but the majority of them said we should just do five days … cause their sort of thinking work life balance family whereas years ago we were a bunch of single guys and we just wanted to work or party. (S9)

This illustrates that the want for change in the industry shaped by those that portray positive qualities that challenge the ‘outsider’s’ view of shearers. It reveals that although a shearing culture exists, and at the moment shapes shearer’s experiences and response to heat, it is not the total reality. Although shearer’s will work in hot unfavourable working environments (that they have no control over) that pose a potential threat to their health to earn a living (they are able to do this through we’ll be right and self regulation), there is a want for change in the industry to improve their working conditions for the future.
5.6 Summary

The underlying storyline throughout the results is that sheep shearer’s will continue to work, and tolerate symptoms when exposed to excess heat, due to how they remunerated for their work. They feel that they have a lack of control over certain variables that contribute to their heat exposure and this has led them to tolerating the symptoms of heat stress as everyday occurrences. This tolerance of symptoms comes from their attitude “we’ll be right” and their ability to self regulate certain behaviours to allow them to continue working in unfavourably hot conditions. The three themes, lack of control, “we’ll be right” and self regulation are all underpinned by the shearing culture and traditional stereotype that was portrayed in the interviews and media. This shearing culture however, is challenged within the industry by workers portraying different qualities and a want for change in the industry in relation to the variables contributing to occupational heat exposure. The next chapter will discuss these thematic analysis results; in relation to previous literature, the implications in terms of standards and guidelines within the industry, discuss the results in relation to the projected increases in temperature from climate change and suggest ideas for future research.
Chapter Six: Discussion

At the outset of the current research the following questions were posed which informed and guided my analysis:

1. What are sheep shearer’s experiences of heat in the shearing industry?
2. How is heat perceived in the shearing industry?
3. How do workers respond to occupational heat exposure?

These research questions were used to explore sheep shearer’s experiences of heat in the sheep shearing industry. In the results chapter they have been discussed as a collective set of questions. In Chapter One the topic of heat as a potential threat to people’s health was introduced, concentrating on workers as a vulnerable population. This was due to the unique environments workers are exposed such as high physically active jobs and outdoor exposures. Chapter Two reviewed the current literature on the topic, it highlighted the gap in qualitative literature and reviewed the quantitative literature on occupational heat measurements, consequences and coping mechanisms. Chapter Three introduced the New Zealand climate in terms of heat exposure and the sheep shearing industry and why workers in this industry may be at risk of occupational heat stress. Chapter Four discussed the methodology behind the research, introducing the constructivist perspective to the current research. It also outlined the data collection and analysis methods for how the sixteen shearer’s experiences and perspectives of heat were sought and analysed through thematic analysis. The results of this thematic analysis were then discussed in detail in Chapter Five.

In overview, the results highlighted that sheep shearers will continue to work, and tolerate symptoms when exposed to excess heat, due to how they remunerated for their work. This is in line with the results from the previous study completed in Australian sheep shearers (Gun & Budd, 1995). Their results showed that shearers productivity did not change when they were exposed to higher heat measurements, although their discomfort scores were elevated and their core body temperature increased (Gun & Budd, 1995). Whilst Gun and Budd (1995) found that shearers do not suffer physiological strain from working in heat, this research indicates that all shearers interviewed suffer from heat related symptoms and perceive it to be problematic in their industry.

Shearers had so often tolerated the symptoms of heat stress that all participants shared experiences of suffering, sometimes perceiving them as normal. This was the case for symptoms such as sweating, cramps, thirst, headaches, light headedness, tiredness and dehydration. This tolerance of such symptoms described in the interviews has previously in the literature been linked to adverse health consequences in occupations including; increased risky behaviour (Slappendel et al., 1993), increased
injury risk (Slappendel et al., 1993), decreased motor response (Jay & Kenny, 2010), decreases in performance task and cognitive function (Kenefick & Sawka, 2007; Tanaka, 2007).

The in-depth results discuss a lack of control over variables that contribute to heat within the industry. This was one of the potential reasons behind why shearers tolerate heat related symptoms that they are exposed to. Shearers responded to the symptoms and lack of control with their “we’ll be right” attitude and their ability to self-regulate their behaviours.

All three themes, lack of control, “we’ll be right” and self regulation, are underpinned by the shearing culture as epitomised in the stereotype of a shearer. This traditional stereotype may have contributed to the tolerance of heat related symptoms as it allows shearers to continue working in any level of heat exposure, due their hard working nature. There is a willingness to get on with the job without complaining therefore tolerating symptoms as a result of heat exposure. This tolerance has led to a reactive response to heat in that shearers deal with consequences of heat stress if and when they arise. Examples in the interview include the self regulation of behaviours; taking fans, drinking water, self pacing and rest. This tolerance and willingness to get the job done without complaint may be why the industry is untouched in terms of guidelines and regulations on occupational heat.

This may be the present situation however; the results also demonstrated a want for change within the industry from the new generation of shearers, which was also recognised by the older generation. Both groups indicate that they may be more likely to challenge the traditional stereotype that is perceived in the industry. This challenge included aspects of change in their drinking culture (with the younger generation knowing more about the effects of alcohol), education (with the younger generation being more educated about their body’s ability) and a the uncomplaining nature of shearer’s (with the younger generation being more outspoken about changes in their industry to allow them to better perform at their job). In the future, this change may lead to an increase in the reporting of heat related accidents in the industry and in turn an increased cost for heat related injuries. The want for change also focuses on improving their working environment. Shearers identified this as the main contributing factor to heat exposure alongside the weather. As there is no control over the weather and shearers have a lack of control over the working environment, the want for change focussed on the standardisation of shearing sheds and their facilities. This would allow shearers to be more productive in the face of projected climate change and decrease the level of tolerance that is currently needed for the exposure to heat.
6.0 Policy Options

6.0.1 Standardisation of Woolsheds

The standardisation of woolsheds and their facilities would include; ensuring all sheds had purpose built ventilation, protection from radiant heat (from corrugated iron roofs and walls), and access to clean drinking water and toilet facilities. These changes would have large impacts on shearer’s experiences of heat in the workplace. This would help to eliminate the lack of control shearers feel over the working environment and give shearers the ability to better manage their response to occupational heat when exposed. The standardisation of shearing sheds may be met with resistance from other parties in the shearing industry, due to the cost of making changes to the workplace. However, as outlined in an earlier chapter, the Health and Safety in Employment Regulations Act says that all workplaces must have access to safe drinking water, toilet facilities and ventilation, whilst also having effective control of humidity and indoor atmospheric conditions (Health and Safety in Employment Relations 1995). Standardisation of woolsheds is a potential way to ensure the current employment law is abided by. It seems from the current results that there is a lack of enforcement in the law which a standardisation of sheds would address. However, this would call for costly industry wide changes, with specific costs being relayed to farmers as owners of the workplace. This is where the nature of employment within the shearing industry makes changes and enforcement difficult.

Shearers are currently employed by shearing contractors, who then work in the shearing sheds owned by the farmers. This complicates the enforcement of the law somewhat as the contractor is legally responsible for the workers and the farmer is legally responsible for the workplace. This leaves a shared responsibility between the contractor and farmer to ensure the work environment and its facilities are at a specific standard. However, this nature of employment has left the industry with no definitive responsibility and therefore a lack of guidelines being written for the variables which contribute to heat. The industry has recognised this problem, previously attempting to highlight the importance of safe facilities in the woolshed, which unfortunately were unsuccessful (N.Z. Department of Labour, 1998). A recent initiative from the industry is one of wool classification, to ensure the wool from farms with acceptable and safe woolshed facilities is recognised.

6.0.2 Wool Classification

A programme with this in mind was introduced in the shearing industry in 2012, the sustainability (productivity) and success of the shearing industry at the centre. The program by ShearNZ is called ‘Pride in People, Product, Country. Integrity and Traceability in Wool Harvesting’ (ShearNZ, 2012). This programme is managed by the New Zealand Shearers Contractors Association and supported by many
organisations throughout the wool industry worldwide. The programme’s overall aim is to get the New Zealand wool industry processes recognised internationally, with New Zealand being recognised as having the best practice. It is a fee based accreditation programme aimed at shearing contractors to ensure a high level of service and sustainable practices in the workplace, emphasising communication between farmers, wool industry and wool harvesting. At the moment the programme is in its infancy, covering only six million of the 50 million sheep shorn in New Zealand. The programme is aimed at shearing contractors to collectively develop tools to run their business in a more formal and reputable ways, with an aspect being the working conditions shearers are exposed to. The accreditation programme has a section on woolshed facilities and requires contractors to complete a warrant of fitness on the woolshed facilities. This warrant includes but is not limited the facilities identified as those that impact more on experience of heat by the participant of the current research; clean drinking water, ventilation and toilet facilities. This programme is a step forward in taking a more proactive approach to address some of the issues with the working environment at the moment. It is also in agreement with the want for change in the industry as outlined in the current results. The programme is an example of how the surrounding organisations within the industry are helping to support the contractors and farmers to abide by the current health and safety regulations. The shearers have no ability to collectively bargain changes in the working environments as they are not unionised. This is also an example of how to improve communication between the farmer and the contractor to advocate for changes in the working environment due to the relatively small number of contractors that cover a large number of farmers.

6.0.3 A Future Proactive Response

Although the ShearNZ program above shows moving forward with the want for change in the industry with regards to all workplace variables, heat included. There is still a reactive response to the occupational heat exposure which is reflective of the current lack of guidelines and enforcement of regulations. This has left heat to be treated as a hazard, with relatively low priority in the shearing industry. This low priority given to occupational heat and its health effects reflects the perspective of many authorities worldwide (Kjellstrom, Kovats, et al., 2009). This perspective is driven through a lack of knowledge in the area of occupational heat for different industries in different regions of the world (Kjellstrom, Kovats, et al., 2009). The projected increases in temperature due to climate change coupled with the deficit in knowledge on the topic has led to a call for public health activity to address occupational heat and its health consequences (Hanna et al., 2011). As described in Chapter Three, temperatures are on the increase worldwide leading to higher heat exposures for workers for longer time periods. With this in mind it is essential to move from a reactive response to occupational heat to
a proactive one, taking steps to create solutions with workers health and productivity at the forefront (Kjellstrom & Crowe, 2011). This would mean an increase in research, both quantitative and qualitative throughout different industries to fill the knowledge deficit and to highlight the need for a more proactive and preventative response to heat. With regards to the shearing industry it would mean investigating the potential impact projected climate change may have on the productivity of the industry. The current results indicate a tolerance of heat related symptoms in the industry. However, due to projected increased in temperature in the future this tolerance level may not be enough to sustain the current levels of productivity.

6.1 Future Research

With this in mind there is a need for investigation into the potential impact heat has on health and productivity in the face of such changes in climate. The Gun and Budd (1995) study assessed thermal strain in the Australian industry and found similar results in that shearers will continue to work no matter what heat levels they are exposed to. However, there needs to be quantification of the impact that working environments and their facilities have on the health and productivity of shearers. This research should include examinations of relationships between heat related accidents, weather variables and shed facilities. This could also include research into the regulation of heat related variables (e.g. WBGT) and the influence insulation, ventilation and passive cooling has on these, to make the shearing shed the safest and most productive it can be. This research would assess the health impacts of occupational heat in the industry and estimate the potential impact that future increases in temperatures might have on health outcomes and productivity. Better understanding of the relationship between heat, health and productivity may lead to an introduction of regulations for the shearing industry such as the surrounding the working environment with a potential standardisation of woolshed sheds and building regulations. Other research that could be included in the area are the qualitative perceptions of other workers in the industry such as farmers, wool handlers and wool pressers. Farmer’s perspectives would give insight into why there is the lack of standardisation in woolsheds from a perspective of the owner of the workplace. It would also identify barriers to standardising woolsheds in terms of design, facilities and cost. Other workers’ perspectives (wool handlers and pressers) would give insight into whether there were any differences of workers in the same environment and whether the same contributing variables that expose shearers to heat would be the same for other workers.
6.2 Limitations

The lack of other workers’ perceptions has been a limitation of the current research but was justified due to the time restraints of the current research and also the accessibility of other workers. In gaining others perceptions and experiences of heat within the industry it may give insight into how to move forward to a preventative response to heat and how to make changes within the industry more accessible in the future.

A preventative and proactive response to heat exposure in the shearing industry would require a standardisation of woolsheds and their facilities. Without this, shearers will continue to tolerate and suffer the health consequences of heat exposure. It is too early in the program to assess whether the wool classification programme will make a difference to the working environment in which shearers are exposed to. If unsuccessful, shearers will need to continue to tolerate heat related symptoms by using their reactive responses to heat, self regulation. If this reactive response to heat continues the health consequences of heat may occur more frequently with the future projected increases in temperature from climate change. Shearers will be exposed to higher temperatures, more often and for longer periods of time, potentially leading to more heat related accidents, incidents and symptoms. The current results indicate that although this may be the case, shearers will continue working no matter what heat conditions they are exposed to, because of the way they are remunerated for their work. This may have led them into a false sense of security with their ability to self regulate their behaviour and tolerate heat symptoms with their “we’ll be right” attitude. As in the future they may be exposed to higher temperatures which may be detrimental to the industry workers health and productivity. These projected increases will pose a potential threat in terms of heat related symptoms beyond shearers’ tolerance levels, potentially leading to a decrease in performance and productivity of the industry as a whole. This relationship between decreased productivity due to higher heat exposures has also been highlighted by others in the literature (Axelson, 1974; Brotherhood et al., 1997; Budd et al., 1997; Kjellstrom & Crowe, 2011; Kjellstrom, Gabrysch, et al., 2009; Kjellstrom, Holmer, et al., 2009; Kjellstrom, Kovats, et al., 2009). This again highlights the importance of the current research in being the first step to explore experiences of heat in the shearing industry in New Zealand.

6.3 Conclusions

Heat is potentially problematic in terms of shearers’ health, and may be even more so in terms of productivity in the face of future climate change.
The current results highlight that shearers tolerate heat and heat related symptoms due to how they are remunerated for their work. Getting paid per sheep brings a high level of extrinsic motivation to work in conditions which may pose a health risk from heat exposure. The remuneration for work is an incentive for shearers to continue working to earn money in which they able to with their “we’ll be right” attitude and self regulation of behaviours, both of which are underpinned by the shearing culture. However due to the projected increases in temperature as a result of climate change, the ability to self regulate behaviours may be hindered if there is not a change in the industry’s perception of heat. At the moment there is a reactive response to heat due to the lack of knowledge of the impacts of heat on health and productivity. A proactive response to heat would call for changes in the industry such as a standardisation in shearing sheds and their facilities (as identified by the participants). However, there was recognition from shearers of the cost of such changes and therefore the tolerance of heat and heat related symptoms continues. There is a need for further research into occupational heat in the shearing industry with a focus on the quantification of the impact heat has on health and productivity. Investigation is also needed into qualitative perceptions of heat from other workers and how to best respond more forward in the industry. In completing this research there is likeliness that there may be changes in heat guidelines and a step towards changing the current reactive response to a proactive one. This will work in favour of the knowing and understanding the how to maintain the current productivity levels and the future sustainability of the industry in the face of climate change.
Appendices

Appendix One: Ethics Approval

Dear Assoc. Prof. Hales,

I am writing to let you know that, at its recent meeting, the Ethics Committee received a copy of the Reporting Sheet relating to your Category B ethics proposal entitled "Heat stress as an occupational health issue in New Zealand".

For your future reference, the Ethics Committee’s reference code for this project is D12/112.

The Committee appreciates that Category B proposals may commence as soon as approval has been obtained at departmental level and that, in some instances, the research or teaching may be well advanced or even completed by the time the Reporting Sheet is received by the Committee.

Nonetheless, in the case of this particular proposal (D12/112), the Ethics Committee has recorded a status for it of Approved HOD at this stage, and has asked me to pass on it’s views to you as follows:-

In the Consent Form please include a tick-box for participants to indicate whether they agree to being identified, or if they choose to remain anonymous, as the Information Sheet states that these options will be provided.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Professor R Edwards  Department of Public Health (Wgnt)
Appendix Two: Information Sheet and Consent Form

Heal stress as an occupational health issue in New Zealand.

INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

Aim of the research

This research project is being undertaken as part of the requirements for a Masters in Public Health. The aim of the project is to determine whether heat stress as an occupational health issue has an effect on people’s health and their ability to do work. The effect of hot temperatures whether they are due to occupational exposure or radiant heat, on New Zealand workers is not well known. We are hoping to contribute to this topic that is growing worldwide. The sheep shearing industry is unique in its exposures due to the nature of the work; the high physical activity rate, the working environment and the seasonality, just to name a few. Throughout this project we are interested in determining whether the industry considers heat stress to be of importance within their industry. This information will be sought through interviews with the primary researcher on this topic. The interviews will address questions on how workers identify heat stress at work, identify any health effects and the workers experiences of working in differing heat exposures. We will look at how the shearing industry manages occupational exposure to heat and hope to quantify the impacts on productivity during hot environmental conditions. The study will also look at the potential impact of global climate change on the industry and consider policy options.

Participants

The participants for the study will be shearing contractors and their employees; sheep shearers. The study will exclude anyone that does not work for a shearing contractor. The participants will be recruited through word of mouth and the networks the researcher has gained from discussions with people from the shearing contractors association. Participants will be contacted by phone and asked to participate in the study after reading this information sheet. There is no limitation on the number of participants as this research is qualitative the researcher will stop collecting data when the information gained from interviews is saturated.

Participation

Should you agree to take part in this project, you will be asked to complete a 20-60 minute interview with the primary researcher, this will either be face to face or a telephone interview. Shearing contractors may also be asked to provide numbers of employee hours and the numbers of sheep shorn over a specified time period.
Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind. Refusal to participate will not impair any existing relationships between the participants and institutions or people involved.

**Data Collection & Management**

The interviews will all be recorded using a digital tape recorder. This will be then be de-identified and transcribed solely by the researcher herself. The data collected will be securely stored in such a way that only those identified below will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

This project involves an open-questioning technique. The general line of questioning includes heat exposure within your workplace. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular question(s) and/or may withdraw from the project without any disadvantage of any kind.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity. On the Consent Form you will be given options regarding your anonymity. Please be aware that should you wish we will make every attempt to preserve your anonymity. However, with your consent, there are some cases where it would be preferable to attribute contributions made to individual participants. It is absolutely up to you which of these options you prefer.

**Questions**

The proposal for this research has been reviewed and approved by the Department of Public Health, University of Otago. If you have any questions about our project, either now or in the future, please feel free to contact either:-

**Lucy Cotterill**
University of Otago Masters Student
Department of Public Health
Telephone Number: 0274185861
Email Address: lucycotterill@live.com

**Simon Hales**
University of Otago Associate Professor
Department of Public Health
Telephone Number: 063642487
Email Address: simon.hales@otago.ac.nz

This study has been approved by the Department of Public Health at the University of Otago. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Heat stress as an occupational health issue in New Zealand.

CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. My participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. Personal identifying information [audio-tapes etc: please specify] will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;

4. This project involves an open-questioning technique. The general line of questioning includes heat exposure within your workplace. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular question(s) and/or may withdraw from the project without any disadvantage of any kind.

5. The results of the project may be published and available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this project:

................................................................................................................................. ...............................
(Signature of participant) (Date)

................................................................................................................................. ........................................
(Participants contact information: phone number and/or email)
Appendix Three: Interview Guides

Interview Guide One

**Part 1. Questions concerning the type of work**
Describe the type of work that you do:

What level of physical activity does your work entail? On a of 1-5 (1 being non, 5 being Very physical).

Does this change during the year?

How many hours per day do you usually work?

Do you work different hours at different times of the year?

If you work **inside**, is it air-conditioned in the summer?
Is the place you work well-ventilated?

If you work **outside**, do you have access to shade?
Do you work in the direct sunlight all during the day (if so, for how long)?

**Part 2. Questions in relation to heat exposure at work**
Is heat exposure a problem at work during the hot season?

How many months of a year do you feel hot or uncomfortable in your workplace?

Is heat and heat stress talked about in your workplace?

Do you drink water at work? Is sufficient drinking water available at all times when you need it?

How much do you drink in a day in hot conditions? ltrs/cups

What clothing do you normally wear to work? (e.g. hats, singlet, short or long sleeved shirt, shorts or long pants.)

**Part 3. Questions concerning impacts of heat on health**
During your work, do you think you have been affected by heat and humidity?

Do you know the symptoms of heat stress? (e.g. heavy sweating, muscle cramps, Tiredness/weakness, dizziness, headache, nausea or vomiting, fainting)

Have you ever had these symptoms at work due to heat?

If so, what symptoms did you have? (e.g. dehydration, loss of concentration, reduced ability to work, increased accidents, fainting and mild or serious heat stroke)

How do you cope, if you are feeling unwell from heat exhaustion?

Have any of your work colleagues ever experienced heat stress that you know of?

If so can you explain in detail, what type of heat effects, how many workers have been affected.
Also, how often does this occur in the hot season and out of how many workers approximately?

**Part 4. Questions concerning impacts on work activities and productivity**
During the hot season, does heat exposure reduce you daily or hourly work output? If so by how much?
Have you lost any wages due to absenteeism in summer months?

If yes, how much ____?(currency

Is heat a problem while you travel to and from work? How does this affect you?

When it has been hot while you have been working, does it affect your home life?
  (e.g. more fatigue than usual, difficult sleeping, unable to carry out your usual recreational and domestic activities).

**Part 5. Heat prevention approaches**

Do you have any concerns about possible future increases in local temperatures?

Are you able to change your work activities during hot times of the day?

Is your organization aware of any safety standards regarding heat? Do they have a policy regarding heat stress in the workplace?

  Does the policy specify a temperature cut off point where work has to be reduced?
  
  What method is used to determine if the temperature threshold has been exceeded?
  
  Are there any factors that make it hard for workers to follow the heat stress policy?

What methods are used by you and your supervisors to manage and or mitigate effects of heat, if at all.

| -- increase staff over summer -- |  |  |  |  |  |
| -- longer work days -- |  |  |  |  |  |
| -- earlier starts -- |  |  |  |  |  |
| -- split shifts -- |  |  |  |  |  |
| -- regular breaks -- |  |  |  |  |  |
| -- lighter protective clothing -- |  |  |  |  |  |

| -- air conditioning -- |  |  |  |  |  |
| -- ventilation -- |  |  |  |  |  |
| -- active rehydration -- |  |  |  |  |  |
| -- more time in the shade -- |  |  |  |  |  |
| -- driving vs walking -- |  |  |  |  |  |

**Part 6. Experience of climate change to date and other questions (e.g. heat exposure outside of work)**

If a heat wave was forecast in the future, to last for over a week would you plan your response in advance?

Have you noticed any tendency towards higher heat exposure during recent years compared to 20-30 years ago (assuming you were around then)?

Have you considered how heat stress may impact you in the future?

Do you have any other comments considering heat, work, health and productivity?
Interview Guide Two

Can you describe your workplace, the environment that you work in?

Owned by?

Can you describe the type of work that you do?

Can you describe any sources of heat in your workplace?

What level of physical activity does your work entail on a scale from 1 – 5? 1- non physical, 5- very physical?

Does this change at all during the year? If so how?

How many hours do you usually work per day?

Do you work different hours at different times of the year? If so can you explain?

When you’re working inside in the shearing shed it is air conditioned? Can you describe the ventilation in the shed if there is any?

Is heat exposure a problem at work during the hot season?

How many months of the year do you feel hot or uncomfortable at work? Which months?

Can you describe an instance where heat was talked about in your workplace? Does this happen often?

Do you drink water at work? What are the sources of water at work? Is sufficient drinking water available when you need it?

How much would you drink in a day in hot conditions? In litres?

Can you describe what clothing you normally wear to work?

Are the clothes designed especially for you work?

Can you describe any symptoms of suffering because of the heat?

When I list them after each one can you say yes or no to having suffered any of these?
Sweating, cramps, tiredness, weakness, dizziness, headache, nausea, vomiting, fainting, dehydration, loss of concentration, reduced ability to work, heat stroke?

During your work can you describe a situation where you’ve been affected by heat and humidity?

Can you describe how you would deal with feeling unwell from working in the heat?

Can you describe a situation where your colleagues have experienced the effects of heat at work?

During the hot season does the heat reduce your daily or hourly output? If so can you describe how?

Can you describe a situation when it has been hot and work and it affects your home life? E.g tiredness, unable to carry out recreational activities?

During hot parts of the day are you able to change your work activities? If so can you describe how you might do this?

Can you describe any methods you or your supervisor use to manage the effects of heat?
Can you describe any safety standards regarding heat in your workplace? E.g. temperature cut offs?

If you could regulate the working environment can you describe an ideal environment for your work?

If a heat wave was forecast in the future to last over a week, so next week is a heat wave, can you describe how you would plan your response in advance?

Have you considered how heat may impact you in the future? Do you have any concerns about increase in local temperatures in the future?

Do you have any other comments or questions about the topic?

Interview Guide Three

Can you talk me through a typical day working as a shearer?

Can you tell me a story about a time when it’s been hot at work and you’ve been affected by heat and humidity?

Can you talk me through a time when you have worked in a “bad shed”?

Can you talk me through a time when you have worked in a “good shed”?

Can you tell me a story about a time you have seen a colleague suffer from heat & humidity at work?

Can you talk me through what makes a good day at work?

What aspects of the weather/ climate affect your work?

Can you talk me through what sets shearing aside from any other occupations?

Can you describe to me the working situation when heat becomes too hot at work? (tipping point)

Can you talk me through any differences that you have experienced with regards to heat in different locations in New Zealand?

If it were to get hotter in this country in the future can you describe how it would affect your work?

Can you describe any changes you have noticed in the shearing season over the past 10 years

Prompts

Can you describe how this changes when it is a hot day?

Can you elaborate more on ....

What were you wearing

What does that involve
References


