"PHYSICAL ACTIVITY, SITTING AND DEPRESSION DURING PREGNANCY"

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Abstract

Aims

The aim of this cross sectional study is to explore levels of physical activity and sitting behaviour amongst a sample of pregnant Australian women (n = 81), and investigate whether reported levels of physical activity and/or time spent sitting were associated with depressive symptom scores after controlling for potential covariates.

Methods

Study participants were women who attended the antenatal clinic of a large Brisbane maternity hospital between October and November 2006. Data relating to participants' current levels of physical activity, sitting behaviour, depressive symptoms, demographic characteristics and exposure to known risk factors for depression during pregnancy were collected; via on-site survey, follow-up telephone interview (approximately one week later) and post delivery access to participant hospital records.

Results

Participants were aged 29.5 (± 5.6) years and mostly partnered (86.4%) with a gross household income above $26,000 per annum (88.9%). Levels of physical activity were generally low, with only 28.4 % of participants reporting sufficient total activity and 16% of participants reporting sufficient planned (leisure-time) activity. The sample mean for depressive symptom scores measured by the Hospital Anxiety and Depression Scale (HADS-D) was 6.38 (± 2.55). The mean depressive symptom scores for participants who reported total moderate-to-vigorous activity levels of sufficient, insufficient, and none, were 5.43 (± 1.56), 5.82 (± 1.77) and 7.63 (± 3.25), respectively. Hierarchical multivariable linear regression modelling indicated that after controlling for covariates, a statistically significant difference of 1.09 points was observed between mean depressive symptom scores of participants who reported sufficient total physical activity, compared with participants who reported they were

engaging in no moderate-to-vigorous activity in a typical week ($p = 0.05$) but this did not reach the criteria for a clinically meaningful difference. Total physical activity was contributed 2.2% to the total 30.3% of explained variance within this model. The other main contributors to explained variance in multivariable regression models were anxiety symptom scores and the number of existing children.

Further, a trend was observed between higher levels of planned sitting behaviour and higher depressive symptom scores ($p = 0.06$); this correlation was not clinically meaningful. Planned sitting contributed 3.2% to the total 31.3 % of explained variance. The number of regression covariates and limited sample size led to a less than ideal ratio of covariates to participants, probably attenuating this relationship. Specific information about the sitting-based activities in which participants engaged may have provided greater insight about the relationship between planned sitting and depressive symptoms, but these data were not captured by the present study.

Conclusions

The finding that higher levels of physical activity were associated with lower levels of depressive symptoms is consistent with the current body of existing literature in pregnant women, and with a larger body of evidence based in general population samples. Although this result was not considered clinically meaningful, the criterion for a clinically meaningful result was an a priori decision based on quality of life literature in non-pregnant populations and may not truly reflect a difference in symptoms that is meaningful to pregnant women. Further investigation to establish clinically meaningful criteria for continuous depressive symptom data in pregnant women is required. This result may have implications relating to prevention and management options for depression during pregnancy.

The observed trend between planned sitting and depressive symptom scores is consistent with literature based on leisure-time sitting behaviour in general population samples, and suggests that further research in this area, with larger samples of pregnant women and more specific sitting data is required to explore potential associations between activities such as television viewing and depressive symptoms, as this may be an area of behaviour that is amenable to modification.

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

I formulated the aims and objectives specific to this thesis and completed a comprehensive review of the literature relating to depression, physical activity and sitting. I extracted and collated data from participant hospital records, conducted all statistical analyses, interpreted the results and authored the subsequent thesis.

Signature: _____

Date: _____

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Chapter 1: Introduction

The following pages provide an introduction to the research undertaken to identify potential relationships between physical activity, sitting and depressive symptoms during pregnancy. Background relating to the research problem will be explored and the context of the research will be outlined (Section 1.1). The intent and purpose of the research will be articulated (Section 1.2) and the significance of the research will be described (Section 1.3). The chapter will close with an outline of the subsequent chapters (Section 1.4).

1.1 BACKGROUND AND CONTEXT OF STUDY

In Western culture pregnancy is perceived to be a joyous time, but for the 7-13% of women who become depressed during their pregnancy, this is not the case (Bennett, Einarson, Taddio, Koren & Einarson, 2004). Depression during pregnancy challenges powerful cultural expectations and produces significant treatment dilemmas for clinicians, particularly in relation to medication. Women who are depressed during their pregnancy are often reluctant to disclose their symptoms and despite antenatal health checks to identify potential threats to maternal and newborn health, mental health issues such as depression can often be overlooked. The consequences of untreated depression during pregnancy range from negative physical health outcomes for mother and child, to functional and social impacts that can damage a woman's ability to care for own health throughout her pregnancy and/or maintain the social relationships that are so significant through the antenatal and postnatal period (Pearlstein, 2008).

Current management strategies for depression during pregnancy, such as interpersonal counselling and medication, have a number of shortcomings relating to cost, safety and acceptability. In contrast, physical activity may offer a cheaper, safer and more acceptable alternative (Dennis, Ross & Grigoriadis, 2007). Nevertheless, the possibility that physical activity may help to prevent or manage depression during pregnancy has barely been investigated although it has shown the capacity to do so in the general (non-pregnant) population (Teychenne, Ball & Salmon, 2008).

The relationship between sitting behaviour (engaging in activities in which one remains seated) and mental health has recently begun to be explored in the general population and some studies have identified an association (Hamer et al, 2010), but this relationship is yet to be investigated in pregnant populations. Physical activity is not contra-indicated in normal low risk pregnancies; in fact current guidelines in Australia and United States of America (U.S.) recommend it (Egger, Donovan, Swinburn, Giles-Corti & Bull, 1999; U.S. Department of Health and Human Services, 2008). However, physical activity usually declines during pregnancy, often to a level deemed 'insufficient' for health benefit (Pereira, Rifas-Shiman, Kleinman, Risch-Edwards, Peterson & Gillman, 2007). When the prevalence and consequences of depression during pregnancy are considered alongside the shortcomings associated with current management strategies such as medication, it is apparent that this is a significant public health issue that may benefit from additional prevention and management options. Interventions based on increasing physical activity and decreasing sitting (inactivity) may offer a number of health benefits, including reductions in or prevention of depressive symptoms. However, before any such interventions are implemented, systematic research that provides an accurate assessment of what (if any) relationships exist between physical activity, sitting behaviour and depression during pregnancy, is required.

The present study focuses on the relationship between physical activity, sitting and depressive symptoms in pregnant women. Depression during pregnancy has received limited research attention, often overlooked in favour of the higher profile (but related) disorder of postnatal depression. The robust evidence linking these disorders suggests that they may be a continuum (Ryan, Milis & Misri, 2005), yet as Austin noted in 2004, "a strong case can be made for early detection and treatment of depression ... in pregnancy as an important target in its own right" (Austin, 2004, para. 12). Subsequently, depression during pregnancy is now identified as an area much in need of investigation, due to the number of associated negative health outcomes for mother and child. In this early research environment, a substantial proportion of investigation has focused on clinical definition (i.e. establishing whether depression during pregnancy is the same as depression at other times) and prevalence. These foci have then been extended to identify risk factors and evaluate whether current management practices are effective or indeed appropriate. A number

of studies have aimed to evaluate interventions based on psychosocial counselling and medication, which typify current management practices. A persistent literature thread has also explored specific psychosocial factors, such as the particular life changes that couples or individuals must face when becoming parents, and the impact of social support.

Within this already limited environment, research about the relationship between physical activity and depression during pregnancy has been the focus of a very small body of literature. Currently, there is no consensus about whether a lack of physical activity is a risk factor for depressive symptoms during pregnancy or indeed if it is associated at all. The relationship between sitting behaviour and depressive symptoms during pregnancy has not been explored at all, although very recent evidence suggests that such a relationship may exist in the general (non-pregnant) population.

Systematic investigation aimed at identifying and describing modifiable risk factors for depressive symptoms during pregnancy is required if research in this area is to progress. One of the initial steps towards this goal is to establish what, if any, relationships exist between the potential risk factors of physical activity and sitting behaviour, and depressive symptoms during pregnancy.

1.2 STUDY AIMS

The first aim of this study is to investigate whether physical activity at a level considered beneficial for health in non-pregnant populations, is associated with lower levels of depressive symptoms amongst a sample of pregnant Australian women, and to evaluate whether any observed association is clinically meaningful. The second aim of this study is to determine whether depressive symptoms amongst a sample of pregnant Australian women are linearly correlated with the amount of time spent sitting, and whether any observed correlation is clinically meaningful.

1.3 SIGNIFICANCE OF THE STUDY

This study builds on a small number of existing research investigations that have reported an inverse relationship between physical activity and depressive

symptoms during pregnancy. Further, this study builds on research based in general population samples that has identified an inverse relationship between physical activity and depression and an association between sitting behaviour and depressive symptoms.

The results of this study will contribute to a greater understanding of physical activity and sitting behaviours amongst pregnant women and their relationship to depression. In addition, this study will help to provide a basis for further research that aims to identify potential intervention points and alternative strategies for the prevention and management of depression during pregnancy.

1.4 THESIS OUTLINE

The next chapter of this thesis provides a review of the literature, describing the symptoms, public health burden and consequences associated with depression during pregnancy. Risk factors and current treatment strategies are outlined. Current literature exploring the relationships between physical activity, sitting and depression is also discussed. Chapter 2 concludes with the overarching research questions of the study. In Chapter 3 the methods used to gather study data are described and details of the survey instruments that were used to measure physical activity, sitting, depressive symptoms and potential covariates are discussed. The criteria for clinically meaningful results and additional information pertaining to statistical assumptions and data analysis are also provided. Chapter 4 provides a demographic profile of the study sample, after which the results of univariate and bivariate analyses of physical activity, sitting and depressive symptom data are summarised. The final models produced by the hierarchical multivariable linear analyses are then presented with references to statistical significance and clinically meaningful criteria. The final chapter will discuss the research findings from the results chapter. A review and interpretation of results is presented alongside potential explanations. Current literature is drawn upon to provide contrasts, comparisons and greater understanding. Strengths and limitations of the current study are then identified, after which implications for practice and policy are discussed. The chapter concludes with suggestions for future research directions.

Chapter 2: Literature Review

2.1 DEPRESSION

Depression is a mood or 'affective' disorder (WHO, 1993) that is "most often episodic, but can be recurrent or chronic" (Murthy, Bertolote, Epping, Funk, Prentice, Saraceno & Saxena, 2001, p.30). The criteria often used to identify depressive episodes are those within the International Statistical Classification of Diseases and Related Health Problems (ICD-10; WHO, 1993) or the Diagnostic and Statistical Manual of Mental Disorders 4th Edition (DSM IV; American Psychiatry Association, ©2000).

The term 'Unipolar Depression' (WHO, 2001) describes a constellation of symptoms identified in ICD-10 (V) and DSM IV that refer to a depressive episode as the primary disorder, excluding depression that occurs as a result of other ailments such as Alzheimer's or brain damage. Accordingly, within this document the terms 'unipolar depression' or simply 'depression' will refer to the set of symptoms listed in Table 2.1, which have been extracted from the ICD 10 (V).

Table 2.1
Symptoms of Unipolar Depression
(Extracted from ICD 10 (V); WHO, 1993)

Key Symptoms	• Depressed mood to an abnormal degree: most of day, most days • Loss of interest/ pleasure in activities that are normally pleasurable • Decreased energy or increased fatigability
Additional Symptoms	• Loss of confidence and self-esteem • Unreasonable feelings of self-reproach; excessive & inappropriate guilt • Recurrent thoughts of death or suicide, or any suicidal behaviour • Diminished ability to think/concentrate (indecisiveness or vacillation) • Change in psychomotor activity (agitation/retardation) • Sleep disturbance of any type • Change in appetite (decrease/increase) & corresponding weight change

2.2 PUBLIC HEALTH BURDEN OF DEPRESSION

The last World Health Report to focus on mental health (Murthy, Bertolote, Epping, Funk, Prentice, Saraceno & Saxena, 2001) stated that unipolar depressive disorders were the leading cause of Years Lost due to Disability (YLD) in 2000, causing 11.9% of total YLD (Murthy, Bertolote, Epping, Funk, Prentice, Saraceno & Saxena, 2001). Gender-based analysis indicated a greater proportion of YLD was attributable to depression amongst women (14%) than men (9.7%). In Australia, anxiety and depression are responsible for 14% of the non-fatal burden of disease, comparable with the combined non-fatal burden attributable to cancer and cardiovascular disease. Anxiety and depression were identified as the leading causes of total YLD among women (10%) and the 3rd leading cause of total YLD among men (4.8%). Within the 15-44 year old age group, anxiety and depression are the leading causes of YLD in both women (27.4%) and men (13%; Begg, Vos, Barker, Stevenson, Stanley & Lopez, 2007). It has been estimated that by 2020, depression will have become the second leading cause of suffering worldwide, second only to heart disease (Khandewal, Chodhry, Regmi, Mendis & Kittirattanapaiboon, 2001).

It is only possible to estimate some of the costs of depression. The easiest costs to predict are the health and social service needs, lost employment and productivity, the negative impact on families and caregivers and potential premature mortality. Costs associated with lost opportunity or the impact on quality of life, however, remain unquantifiable in economic terms (WHO, 2001). While there is limited information relating to economic burden, one estimate suggests that in 1997-98 depression cost Australia around $400 million (U.S.) directly and $1.4 billion (U.S.) indirectly (Hu, 2004). Further, lower direct costs due to lack of treatment may increase indirect costs due to longer-term disability (WHO, 2001). As depression is associated with increased risk of suicide (WHO, 2001), ischemic heart disease (Surtees, Wainwright, Luben, Wareham, Bingham & Khaw, 2008) and excess morbidity when comorbid with chronic physical illness (Moussavi, Chatterji, Verdes, Tandori, Patel, & Ustun, 2007), it should be acknowledged that the social and economic burden of depression extends beyond the boundaries of the illness itself, increasing the disease burden of other health issues as well (WHO, 2001; Moussavi, Chatterji, Verdes, Tandori, Patel, & Ustun, 2007).

There is considerable evidence indicating that depression is associated with a high degree of functional impairment (Kessler, Akiskal, Ames, Birnbaum, Greenberg, Hirschfeld, Jin, Merikangas & Wang 2006; Judd, Schettler, Solomon, Maser, Coryell, Endicott, & Akiskal, 2008; Adler, McLaughlin, Rogers, Chang, Lapitsky, & Lerner, 2009); significant morbidity (Goldney, Fisher, Wilson, & Cheok, 2000; Gorwood, Corruble, Falissard, & Goodwin, 2008); and excess mortality (WHO, 2001; Cuijpers & Smit, 2002; Louche, 2009). Whilst this is true for depression alone, the impact is intensified when depression is co-morbid with other illnesses such as asthma, arthritis, angina, diabetes or ischemic heart disease (Moussavi, Chatterji, Verdes, Tandori, Patel, & Ustun, 2007).

The public health burden of depression is immense. The negative outcomes relating to function, morbidity and mortality all suggest that depression is a significant public health issue that warrants research attention.

2.3 PREVALENCE OF DEPRESSION

In 2007, data from the World Health Surveys estimated that the global prevalence for ICD-10 defined depressive episodes in the previous year was 3.2% (Moussavi, Chatterji, Verdes, Tandori, Patel, & Ustun, 2007). In the same year, depressive episode was the most common affective disorder in Australia with 4.1% of those interviewed for the 2007 National Survey of Mental Health and Wellbeing indicating they had experienced a depressive episode in the preceding 12 months (Slade, Johnston, Teesson, Whitford, Burgess, Pirkis & Saw, 2009).

The prevalence of depression varies with age. International data indicate a peak in the prevalence of depression in the 15-44 year age category (WHO, 2001). U.S. data indicate peak prevalence in young adults (15-24 years) while Australian and British data indicate peak prevalence in middle age (45-54 years; Wilhelm, Mitchell, Slade, Brownhill, & Andrews, 2003).

The prevalence of depression also varies according to gender. The World Health Organisation has indicated that globally, women experience depression at a rate approximately twice that of men (Astbury, 2001). Australia reflects this global picture with the prevalence of depressive episodes being at least 2% higher among Australian women (5.1%) compared to Australian men (3.1%; Slade et al, 2009).

Several theories have been put forward in the literature to explain gender differences in the prevalence of depression, although no single theory holds precedence (Nolen-Hoeksema, 2006). What is most important to this thesis is that in most populations, depression rates are highest for women during their childbearing and child rearing years (O'Keane & Marsh, 2007); and consequently some of the excess prevalence in women is attributable to depression occurring in the antenatal period (pregnancy). The remainder of this literature review will focus on depression occurring during pregnancy.

2.4 DEPRESSION DURING PREGNANCY

According to Cox & Holden (2003), the signs and symptoms of depression during pregnancy do not differ from depression at any other time. These symptoms include depressed mood for most of the day, anhedonia (inability to experience pleasure), feelings of worthlessness or excessive or inappropriate guilt, decreased concentration, increased indecisiveness, recurrent thoughts of death or suicide and some somatic symptoms such as fatigue and sleep disturbance (American Psychiatric Association, 2000). Other research supports the assertion that depression during pregnancy is defined only by timing of onset, finding that although suicidality may be less severe and some somatic symptoms may vary (Manber, Blasey & Allen, 2008; Marzuk, Tardiff, Leon, Hirsch, Portera, Hartwell & Iqbal, 1997), there are no major differences in the symptoms of depression with onset during pregnancy and depression with onset at other times (Manber, Blasey & Allen, 2008). The distinct lack of mention of depression during pregnancy in the ICD-10 (V) and DSM IV (American Psychiatric Association, 2000; WHO, 1993) also reflects the consensus that depression during pregnancy does not differ from depression at other times (Bowen & Muhajarine, 2006).

The 2005 Agency for Healthcare Research and Quality systematic review (Gaynes, Gavin, Meltzer-Brody, Lohr, Swinson, Gartlehner, Brody & Miller, 2005) of the depression prevalence literature (studies published in English) gave a prevalence range for combined major and minor depressive episodes occurring during pregnancy of 8.5% to 11%, and a range of 3.1% to 4.9% for major depression alone (Gaynes, Gavin, Meltzer-Brody, Lohr, Swinson, Gartlehner, Brody & Miller,

2005). Confidence intervals around these prevalence rates are wide, and there is still a fair amount of uncertainty in the combined estimates from which the rates are formulated (AHQR, 2005). However by way of comparison, the prevalence of major depression amongst women in the general population worldwide is 3.2% (WHO, 2001). Another recent systematic review of prevalence literature (studies published in any language) reported the prevalence of depression during pregnancy to be 7.4% in trimester one, increasing to between 12 and 13% in the second and third trimesters (Bennett, Einarson, Taddio, Koren & Einarson, 2004). The authors of this second review stated that the estimated prevalence rates were likely to be conservative. This is particularly true for trimester one, where because only a few small studies met the inclusion criteria, it was suggested that the 'true' prevalence was probably greater than had been estimated. Despite the uncertainty around prevalence rates, the evidence suggests that far from being protective against mental illness as was once thought (Bonari, Pinto, Ahn, Einarson, Steiner & Koren, 2004), pregnancy is a life-phase where at least in the second and third trimesters, depression prevalence may be greater than any other phase of a woman's life.

2.4.1 NEGATIVE CONSEQUENCES OF DEPRESSION DURING PREGNANCY

Until relatively recently, depression during pregnancy had not received much investigative attention, possibly due to a belief that pregnancy was protective against depression (Evans, Heron, Francomb, Oke & Golding, 2001). However, evidence increasingly suggests that depression in pregnancy may put a woman and her unborn child at risk of a number of negative outcomes (Evans, Heron, Francomb, Oke & Golding, 2001).

Depression at any time may result in significant disability, as noted in section 2.1.2; and this risk of disability remains true for depressed pregnant women. Mental illness during pregnancy can affect a woman's functional status, ability to obtain prenatal care, compliance with prenatal advice and ability to avoid unhealthy behaviours such as smoking, alcohol consumption and use of other drugs (Bonari et al., 2004). Accordingly, it is recommended that depressed pregnant women who are not receiving treatment should be regularly monitored for suicidality, deteriorating social and physical functions and inability to comply with healthcare (specifically obstetric) advice (Wisner, Zarin, Holmboe, Appelbaum, Gelenberg, Leonard &

Frank, 2000). Further, while women who are pregnant have a significantly lower risk of suicide than women of childbearing age who are not pregnant (Marzuk et al., 1997), suicide still contributes to a significant proportion of deaths that occur during pregnancy (Confidential Enquiry into Maternal and Child Health, 2004; McGowan, Sinclair & Owens, 2007).

A number of research studies have found that depression during pregnancy may have negative consequences for pregnancy outcomes. Untreated depression during pregnancy has been linked to gestational hypertension (and subsequent preeclampsia), spontaneous abortion, bleeding during pregnancy and increased uterine artery resistance (impairing blood flow to the uterus; Bonari et al., 2004). At birth, it has been linked to spontaneous early labour, caesarean or assisted deliveries and a more painful experience of labour requiring higher use of epidural analgesia (Bonari et al., 2004).

Recent research investigating outcomes for children born to depressed mothers has indicated both short and long-term negative outcomes. Neonates born to depressed mothers have been found to have lower Apgar scores ("a way to judge the condition of a newborn baby"; Apgar, 1966, p. 645), and higher rates of admission to a neonatal care unit, neonatal growth retardation, fetal death, low birthweight and high cortisol levels at birth (Bonari et al., 2004). In addition, children born to depressed mothers are at increased risk for violent anti-social behaviour during adolescence, independent of other risk factors such as socioeconomic status (SES) and re-exposure to maternal depression (e.g. postnatal depression). It has been hypothesised that this long-term consequence is a result of neurobiological deficits due to the effect of antenatal insults on foetal development (Hay, Pawlby, Waters, Perra & Sharp, 2010).

Finally, depression during pregnancy is a known predictor of postnatal depression (Ryan, Milis & Misri, 2005; Leigh & Milgrom, 2008), suggesting that postnatal depression may be "part of a continuum, with onset of illness during pregnancy" (Ryan, Milis & Misri, 2005, p. 1088).

The health and social consequences of depression during pregnancy are severe and can potentially impact two generations. On the basis of prevalence and consequences, further investigation is warranted.

2.4.2 MANAGEMENT AND PREVENTION OF DEPRESSION DURING PREGNANCY

Public health interventions aiming to prevent the onset of depression during pregnancy have been predominantly psychosocial or psychological and generally aimed (unsuccessfully) towards reducing the incidence of postnatal depression, with reduction in the incidence of depression during pregnancy regarded as a secondary aim or incidental outcome (Austin, 2004). Thus far, preventative interventions implemented in the antenatal period have not produced conclusive results for either antenatal or postnatal populations (Dennis, 2004; Barrera, Torres & Munoz, 2007).

Australia does not currently have a systematic approach to managing diagnosed depression during pregnancy, although clinical practice guidelines are being drafted. Nevertheless, publications provided by sources such as the Royal Australian College of General Practitioners (RACGP) or *beyondblue* make a number of recommendations for Australian healthcare professionals. Both sets of guidelines recommend psychological or psychosocial counselling for the management of mild-to-moderate depression, antidepressant medication for moderate-to-severe depression, and ongoing monitoring for women displaying depressive symptoms who do not meet clinical diagnostic criteria (Austin, 2003; *beyondblue*, 2010).

Current prevention or management approaches have a number of identified shortcomings relating to feasibility, risk and compliance. A Cochrane review of the limited evidence for psychological and psychosocial counselling within depressed pregnant populations noted that these approaches can be time-consuming and that they require trained health professionals for delivery, suggesting they may be unfeasible in many settings (Dennis, Ross & Grigoriadis, 2007). Perhaps more significantly, treating depression during pregnancy with medication has been the subject of considerable debate due to concerns about the safety of anti-depressant medication during pregnancy (Austin, 2003). While medication is known to be effective (Freeman, 2007), it may also increase the risk of miscarriage and impact the growth, gestational age and neuro-behavioural outcomes of neonates (Yonkers, Wisner, Stewart, Oberlander, Dell, Stotland, Ramin, Chaudron, & Lockwood, 2009). An additional issue is that many women who are prescribed medication use an inadequate dosage. This probably relates to reluctance by both women and their health care providers to expose the foetus to pharmacological risks; however, this approach has the potential to simultaneously expose the foetus to risks relating to

both the medication and the ongoing depression (Marcus, 2009). Considering that leaving the depression untreated is also associated with negative sequela for mother and child, treating depression during pregnancy with medication requires a careful assessment of the 'risk-to-benefit' ratio (Austin, 2003).

One potential prevention and management option that is relatively low-cost, feasible and free from negative physiological side effects is physical activity (Dennis & Allen, 2008). Physical activity has been shown to be an effective treatment for depression in the general population (Dunn, Trivedi, Kampert, Clark & Chambliss, 2005), and it is not contra-indicated in a normal low risk pregnancy (Drake, 2003). However to date, there have been no clinical trials evaluating physical activity interventions for women diagnosed with depression during pregnancy (Dennis & Allen, 2008).

Physical activity also has evidence supporting its use as a prevention strategy in the general community (Collins & Dozois, 2008; Conn, 2010), yet only one study involving depression prevention in a pregnant population was found in the literature (Koniak-Griffin, 1994). This intervention used a 6 week aerobic-based exercise programme for a self selected group of pregnant adolescents. Results of this study indicated fewer depression symptoms in the exercising group compared with the non-exercisers; however, there were a number of limitations with the study including selection bias due to participants self-selecting whether they were in the intervention or control group (Poudevigne & O'Connor, 2006).

The relevant literature highlights a need for research into alternative approaches, including further investigation of the risk factors that may be targeted for interventions that alleviate symptoms and consequently reduce depression's negative effects.

2.5 RISK FACTORS FOR DEPRESSION DURING PREGNANCY

Risk factors for depression during pregnancy are assumed to be similar to those for unipolar depression: they are complex and inter-related. For this reason this review will focus on what is known about the risk factors for unipolar depression, noting where evidence (if any) exists for specific risk factors for depression during pregnancy. Some of the risk factors for depression may be difficult or impossible for

an individual to alter and are considered *non-modifiable* ; some factors may be more amenable to change and are therefore *modifiable*. This review will consider these clusters of risk factors separately, starting with the non-modifiable risk factors.

2.5.1 NON MODIFIABLE RISK FACTORS FOR DEPRESSION DURING PREGNANCY

Although they are difficult or impossible for an individual to alter, *non-modifiable* risk factors need to be considered in terms of how they highlight individual risk for depression; and therefore help to identify women who may benefit from interventions targeting modifiable factors.

Heritable Factors

It is believed that genetic factors account for approximately 29% of the risk of depression in men and 42% in women (Goldberg, 2006). In addition, particular genes are known to interact with life events, reflected by a linear relationship between the number of stressful life events and the likelihood of depression in those who are genetically vulnerable. Personality traits that are partly heritable, such as avoidance of harm, anxiousness and pessimism, can also influence the risk of depression (Belmaker & Agam, 2008).

Gender

No single cause has been identified to explain the higher prevalence of depression in women; however, three main themes appear in the literature (Nolen-Hoeksema, 2006). The first is that women have more exposure to certain stressors than men, due to differences in social roles and socio-cultural status. The second is that as a result of biological and socialisation factors, women are more likely than men to react to stressors with depressive symptoms. The third major theme is that the cumulative impact of more frequent stress and stress reactivity causes women to be more vulnerable to depression over time (Nolen-Hoeksema, 2006). A subsidiary theme also suggests that women are more willing to seek help for depressive symptoms and are therefore more likely to be diagnosed (Culbertson, 1997). Additional theories relating to depression in women suggest that reproductive hormones may play a significant role in the development of depression during a

woman's reproductive years (Wisner, 2002; Goldberg, 2006; Brummelte & Galea, 2010). It is self evident that gender is a risk factor shared by all pregnant women.

Biological Factors

A number of neuro-chemicals, such as monoamine, norepinephrine, tryptophan, serotonin and dopamine, have been implicated directly or indirectly with the development of depression (Belmaker & Agam, 2008). The "Monoamine-Deficiency Hypothesis" of depression acknowledges the influence of these chemicals and has demonstrated good predictive power; however, it is derived from observing the impact of currently available anti-depressants and does not explain depression in individuals who either do not respond to antidepressants or instead respond to a placebo (Belmaker & Agam, 2008).

Age

Prevalence statistics indicate increased risk of depression between the ages of 15 and 54 years (WHO, 2001; Wilhelm, Mitchell, Slade, Brownhill, & Andrews, 2003). Age is also a risk factor for depression during pregnancy; in this context it is falling pregnant at a young age that increases the risk of depression (Ryan, Milis & Misri, 2005).

Family Background and Early Environmental Influence

A family history of depression is a risk factor for depression. Individuals with a family history of major depressive episodes may be twice as likely to experience a major depressive episode (Wang, Williams, Lavorato, Schmitz, Dewa & Patten, 2010). Depression is also associated with an individual's early environment, particularly in relation to maternal attachment and, especially among those who are genetically vulnerable. Neglect, physical or sexual abuse and major losses, such as the death of a parent, are all associated with an increased risk of depression in adult life (Goldberg, 2006; Beck, 2008).

Previous Depression

After an initial episode of depression, an individual is at higher risk for further depressive episodes. At least 50% of those who recover from a first depressive episode will go on to have one or more additional episodes (Burcusa & Iacono, 2007). This association also exists between antenatal and postnatal depression, where depression during pregnancy is one of the strongest predictors of postnatal depression (Ryan et al, 2005; Leigh & Milgrom, 2008). A personal history of depression and premenstrual dysphoric disorder is also significantly associated with depressive symptoms during pregnancy (Bennett et al, 2004; Bowen & Muhajarine, 2006; Lancaster, Gold, Flynn, Yoo, Marcus & Davis, 2010).

Pregnancy Related Factors

Non-modifiable factors specific to the circumstances surrounding pregnancy and childbirth that increase the risk for depression during pregnancy are unplanned pregnancy, a greater number of existing children and a history of previous abortions (Ryan et al, 2005; Bowen & Muhajarine, 2006).

2.5.2 MODIFIABLE RISK FACTORS FOR DEPRESSION DURING PREGNANCY

Socioeconomic Status

There is a social gradient associated with depression (i.e., individuals with lower socioeconomic status have higher odds of experiencing a depressive episode). Most specifically, a dose response relationship has been observed between depression and education and income (Lorant, Deliège, Eaton, Robert, Philippot, & Ansseau, 2003). However, the relationship between socioeconomic status and depression during pregnancy is inconsistent (Lancaster et al., 2010).

Physical Health

Health problems increase the risk of depression in the general population (Cassano & Fava, 2002). This is also true for pregnant women, particularly if bed-rest is required (Maloni, Kane, Suen, & Wang, 2002). The association between

health and depression appears to be bidirectional (i.e., physical illness contributes to depression and depression contributes to physical illness; Thomas, Kalaria & O'Brien, 2004).

Stress

Stress is associated with an increased risk of depression. The mechanism by which higher levels of stress may increase the risk of depression is not completely understood; however, it may in part be due to the influence of cortisol and its central releasing factor, cortico-tropin-releasing hormone (CRH; Belmaker & Agam, 2008). The impact of stress may be compounded in populations with low socio-economic status (Siegrist, 2008) or with a history of stressful early childhood events (Beck, 2008). Life stress as a result of negative life events has also been associated with an increased risk of depression during pregnancy (Lancaster et al, 2010; Ryan et al, 2005).

Anxiety

Almost 60% of individuals with major depression also meet the criteria for an anxiety disorder. It has been hypothesised that apart from sharing similar genetic factors, a risk pathway that includes impairment and physical illness resulting from anxiety, links the two disorders (Bjelland, 2004). A recent systematic review of studies investigating depression during pregnancy found that anxiety showed one of the strongest associations with depressive symptoms during pregnancy (Lancaster et al, 2010).

Social Factors

Loneliness or social isolation is associated with depressive symptoms (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006) as is the quality of the social ties that an individual maintains, particularly in relation to their spouse or partner (Nolen-Hoeksema & Ahrens, 2002). Furthermore, low social support has been linked to chronic depression (Holzel, Harter, Reese & Kriston, 2010), and an association between perceived social support and severity of depressive episodes has been documented by researchers (Nasser & Overholser, 2005). The literature therefore

suggests that social factors have ongoing significance for the development, length and severity of depressive episodes. Social factors are also strongly associated with depression during pregnancy, where research has indicated significant links to single motherhood, lack of social support, lack of partner support and domestic violence (Ryan et al, 2005; Lancaster et al, 2010).

Alcohol and Other Substance Abuse

A complex relationship exists between substance use and depression. While it is known that alcohol/substance abuse and depression often appear together, it is unclear as to whether one can be said to cause the other or whether additional factors cause both. One explanation for the lack of unidirectional and consistent patterns of association is that multiple mechanisms of co-morbidity are acting simultaneously (Swendsen & Mazure, 2000). Investigations into alcohol and other substance abuse as risk factors for depression during pregnancy have demonstrated inconsistent findings (Lancaster et al, 2010).

Diet

Diet quality is coming under increasing scrutiny as a modifiable risk factor for depression. At present, direction of causality has not been comprehensively established; however, it is known that highly refined diets, including what is considered a 'typical western diet' and high soft drink consumption, are associated with increased risk of depression (Akbaraly, Brunner, Ferrie, Marmot, Kivimaki & Singh-Manoux, 2009; Jacka, Pasco, Mykletun, Williams, Hodge, O'Reilly, Nicholson, Kotowicz & Berk, 2010; Jacka, Kremer, Leslie, Berk, Patton, Toumbourou & Williams, 2010; Shi, Taylor, Wittert, Goldney & Gill, 2010).

Pregnancy Related Factors

The literature investigating risk factors associated with depression during pregnancy identifies that in addition to those factors shared with depression in the general population, two known modifiable risk factors are specific to the circumstances surrounding pregnancy. These are ambivalence or negative feelings about the pregnancy and anxiety about the foetus (Bowen & Muhajarine, 2006).

Physical Inactivity

An increasing body of literature identifies physical inactivity as a risk factor for depression (Camacho, Roberts, Lazarus, Kaplan, Cohen, 1991; Mobily, Rubenstein, Lemke, O'Hara, Wallace, 1996; Dunn, Trivedi, Kampert, Clark, Chambliss, 2005; Ströhle, 2009). Although the association between physical activity and depression may be bidirectional, there is growing evidence that physical activity (even in low doses) is protective against depression (Heesch, Burton & Brown, 2010; Teychenne, Ball & Salmon, 2008).

The mechanisms through which physical activity may assert its protective effect are not well understood, but are believed to involve a complex interaction of psychological and neurobiological factors (Ströhle, 2009). Investigations designed to evaluate this relationship in pregnant populations are small in number.

One small prospective cohort study examined the relationship between changes in physical activity and changes in mood as pregnancy progressed in 12 active pregnant women (Poudevigne & O'Connor, 2005). The authors found no support for the hypothesis that changes in physical activity would result in moderate correlations with changes in mood. However, key limitations of the study included the small sample size (n = 12) and the small changes in physical activity and mood that prevented a strong test of the hypothesised relationships (Poudevigne & O'Connor, 2005; Poudevigne & O'Connor, 2006).

Three other studies with larger samples have reported findings that suggest that physical inactivity is associated with depressive symptoms during pregnancy (Da Costa, Rippen, Drista & Ring, 2003; Downs & DiNallo, 2008; Bowen, Stewart, Baetz & Muhajarine, 2009). Da Costa et al.'s Canadian study (2003) investigated depressive symptoms and leisure-time physical activity in 180 women, once per trimester in their first two trimesters of pregnancy, and monthly in their third trimester. The authors of the study reported that depressive symptoms were significantly lower in women who reported some moderate-to-vigorous leisure-time physical activity in the trimester being assessed. Downs and DiNallo's U.S.-based study (2008) explored associations between exercise behaviour, body image satisfaction and depressive symptoms in a private medical clinic (pregnant)

population that was more active than the national average (n = 230). Physical activity was measured using self-report midway through the first, second and third trimesters, and 6 wks postpartum. The findings from this study indicated that pre-pregnancy exercise of 120 minutes or more per week was associated with reduced risk for depression during the first trimester of pregnancy compared with women who exercised less than 120 minutes per week. Bowen et al.'s (2009) Canadian study investigated exercise (mostly walking) along with other potential determinants of depression within a socially vulnerable minority (pregnant) population (n = 261). This initial cross-sectional portion of a longitudinal study found that women who exercised for at least 20 minutes per day were significantly less likely to be depressed than those who exercised occasionally or not at all. This thesis will focus solely on exploring the relationship between physical activity, sitting and depressive symptoms amongst pregnant Australian women attending a large public hospital antenatal clinic.

Sitting

Although originally considered the functional opposite of physical activity, recent research indicates sitting behaviour, is a separate construct that is associated with negative mental health outcomes including depressive symptoms, independent of physical activity levels (Hamer, Stamatakis & Mishra, 2010). Causality is yet to be established; however, this association suggests that sitting, particularly during leisure-time, is an independent risk factor for depression (Ussher, Owen, Cook & Whincup, 2007). Further, a recent study has identified a synergistic relationship between physical activity, television/screen entertainment time (a proxy for sitting behaviour) and psychological distress. Both physical activity and television/screen entertainment were independently associated with poorer mental health, and they also interacted to increase psychological distress (Hamer, Stamatakis & Mishra, 2009). Sitting as a risk factor for depression during pregnancy has not yet been investigated, and is one of the foci of this thesis.

2.6 PHYSICAL ACTIVITY, SITTING AND DEPRESSION DURING PREGNANCY

Physical activity is not contra-indicated during a low risk (normal) pregnancy. The American College of Sports Medicine (ACSM) states that physical activity can be safely incorporated into a women's routine during pregnancy even if she has previously been inactive (Drake, 2003). Additionally, the U.S. government's 2008 Guidelines for Active Americans recommend that pregnant women who are accustomed to vigorous activity can continue to do it throughout their pregnancy (under their health practitioners guidance); further, that women who are not already active should accumulate at least 150 minutes of moderate-intensity physical activity each week of their pregnancy and during the post partum period (U.S. Department of Health and Human Services, 2008). Australian guidelines also reflect the same recommendations, only cautioning that vigorous activity should be undertaken under medical supervision (Egger, Donovan, Swinburn, Giles-Corti & Bull, 1999).

There is also a growing evidence base suggesting that physical activity during pregnancy is associated with improved maternal and child health outcomes, such as reductions in the risk for pre-term birth (Juhl, Andersen, Olsen, Madsen, Jorgensen, Nohr, & Andersen 2008), preeclampsia, gestational diabetes, and benefits in short and long term offspring health and development (Pivarnik, Chambliss, Clapp, Dugan, Hatch, Lovelady, Mottola & Williams, 2006).

As previously noted, in the general population physical activity is associated with reduced risk of depression (Kritz-Silverstein, Barrett-Connor, Corbeau, 2001) and physical inactivity is associated with increased risk of depression (Dunn et al., 2005; Teychenne et al., 2008), although the mechanisms by which this occurs are not well understood (Ernst, Olson, Pinel, Lam & Christie, 2006). Emerging evidence indicates that this association may also be true for depression during pregnancy (Da Costa, Rippen, Drista & Ring, 2003; Downs & DiNallo, 2008; Bowen, Stewart, Baetz & Muhajarine, 2009) and that physical activity may be an effective strategy for the prevention of depression during pregnancy (Koniak-Griffin, 1994).

Despite the guidelines and obvious benefits of physical activity during pregnancy, research exploring physical activity levels in pregnant populations indicates that activity levels decrease during pregnancy, with the prevalence of insufficient activity almost doubling between pre-pregnancy and the second trimester

of pregnancy (Pereira, Rifas-Shiman, Kleinman, Risch-Edwards, Peterson & Gillman, 2007).

Sitting behaviour has not yet been investigated in relation to pregnancy, although there is a small evidence base indicating that it is a separate construct from physical activity, operates synergistically with low physical activity, and is associated with negative physical (Katzmarzyk, Church, Craig & Bouchard, 2009) and mental (Ussher et al, 2007; Hamer et al, 2009; Hamer et al, 2010) health outcomes in the general population.

Systematic investigation within pregnant populations is required to establish whether physical activity and sitting behaviour are potentially effective depression intervention points that address key issues of current practice (i.e., feasibility, risk and compliance; while offering broader health benefits.

2.7 SUMMARY

Depression is a syndromal affective disorder characterised by sadness, loss of interest in activities, and decreased energy. There is no single cause of depression. Rather it is believed to be the result of multiple bio-psycho-social risk factors accruing and interacting; however, one initial depressive episode significantly increases the risk of subsequent episodes.

The 12 month prevalence of depression in the Australian population is estimated to be around 4.1% (Slade et al., 2009); however, under-diagnosis is common and the actual rate may be much higher. The loss of function, morbidity and mortality associated with depression is considerable, and it is the leading cause of years lost due to disability in Australia. Australian estimates indicate that depression is more common in women (5.1%) than men (3.1%), especially during childbearing and childrearing years (24 to 54 years of age; Slade et al., 2009; Wilhelm et al, 2003), and this can have a significant negative impact on their offspring.

The prevalence of depression during pregnancy is as high, if not higher, than that of postnatal depression, yet it has received less investigative attention. Further, women who are depressed during pregnancy often go on to develop postnatal depression. Current practice involves treatment with psychosocial/psychological or

pharmacological interventions after depression has been identified. These treatment strategies, particularly in the case of medication, can be unpalatable to the target population. Current treatment and prevention strategies rarely utilise the known antidepressant properties of physical activity. This is possibly because despite considerable evidence in the general population, links between physical activity and depression during pregnancy have not been systematically investigated, until recently. Two recent studies have shown that pre-pregnancy exercise may be related to lowered risk for depression during the first trimester of pregnancy and that exercise may be particularly important in reducing risk for depression in high-risk populations of pregnant women.

Nevertheless the lack of purposeful / systematic investigation of physical activity in pregnant women is particularly salient considering that medication is such a vexed issue during pregnancy, and that physical activity may also offer additional benefits specific to pregnant women and their offspring.

Sitting behaviour has only just begun to be explored in the general population; however, the available evidence indicates that it is an independent risk factor for depression and operates synergistically with low physical activity to increase the risk of depression. This construct has not been explored at all in relation to depressive symptoms amongst pregnant populations.

A considerable knowledge gap in relation to the impact of both physical activity and sitting behaviour on depressive symptoms amongst pregnant women exists. To progress research towards well-designed and acceptable interventions that may alleviate depression during pregnancy, systematic investigation of both physical activity and sitting behaviour in pregnant populations is required. The focus of this thesis is to explore a possible relationship between patterns of physical activity, sitting behaviour and depressive symptoms in pregnant women attending a large Brisbane hospital antenatal clinic.

2.8 AIMS OF THESIS

This thesis aims to address two specific research questions:

1. Is there a relationship between physical activity and depressive symptoms during pregnancy?

   H_1: Participants who report regular moderate-to-vigorous physical activity will have lower levels of depressive symptoms than women who report no moderate-to-vigorous physical activity

2. Is there a relationship between the amount of time spent sitting and depressive symptoms during pregnancy?

   H_1: The amount of time that participants report that they spend sitting will be positively correlated with depressive symptom levels

To address these questions research and analysis will:

1. Explore possible models of association between depressive symptoms and physical activity among pregnant women visiting a large Brisbane hospital antenatal clinic between October and November 2006.
2. Explore possible models of association between depressive symptoms and length of sitting time among pregnant women visiting a large Brisbane hospital antenatal clinic between October and November 2006.
3. Explore possible models of association between depressive symptoms and the combination of physical activity and length of sitting time, among pregnant women visiting a large Brisbane hospital antenatal clinic between October and November 2006.

Chapter 3: Methods

3.1 STUDY AIM AND DESIGN

This study aimed to investigate whether there is a relationship between physical activity and sitting and depressive symptoms during pregnancy. Levels of physical activity, sitting and depressive symptoms were assessed in a cross-sectional study of pregnant women. Women were recruited from the antenatal clinic of a large Brisbane hospital. Data were collected in 2006 via self report surveys at the clinic and follow-up telephone interviews approximately one week after the clinic survey. Further data pertaining to the outcome of the participant's 2006 pregnancy were obtained from their hospital records in 2009.

3.2 ETHICS

This study was approved by a University of Queensland Human Research Ethics Committee (HMS606/3003) and a Brisbane maternity hospital ethics committee (PROTOCOL 2006/077). Prior to accessing participant hospital records in 2009, the hospital ethics committee was re-contacted to confirm that access was still allowable under the terms of the original approval and approval was confirmed.

3.3 PARTICIPANTS

All pregnant women who visited the hospital's public antenatal clinic between 31/10/2006 and 10/11/2006 were invited to participate. The only inclusion criterion was that the women were currently pregnant. Potential participants were excluded if they were unable to give informed consent or unable to read, write or understand English sufficiently well enough to provide informed consent and/or complete the self report surveys.

3.4 SAMPLE RECRUITMENT

Pregnant women waiting for their antenatal clinic appointment were approached by a research assistant and asked if they would be interested in completing a 15 minute survey on location followed by a telephone interview up to one week later. They were also asked for permission to access their medical records following the completion of their current pregnancy. Participants who chose not to participate were not asked for further information or re-approached. Women who agreed to participate provided written information and an informed consent form (see Appendix A).

A total of 151 women attended the antenatal clinic during the recruitment period. Of these, 137 were approached by a recruiter; 14 were not approached because they were called to their appointment before they could be asked to participate. Of 137 women who were approached, 114 consented to participate (83.2%). Basic demographic information, physical activity and sitting data were collected from women who completed the short survey by self-completion and with researcher assistance, at the hospital antenatal clinic. A depressive symptoms scale and additional demographic, health and physical activity data were collected from women who completed the telephone interview approximately one week later.

While 106 women provided data in at least the short survey or the telephone interview, complete data from both these sources were available for 90 women. Specific antenatal information, details of birth and post delivery health data were collected from the hospital records of 81 women. The flow of participants through the recruitment and data collection process is illustrated in Figure 3.1. Data from 81 women were included in the final analyses.

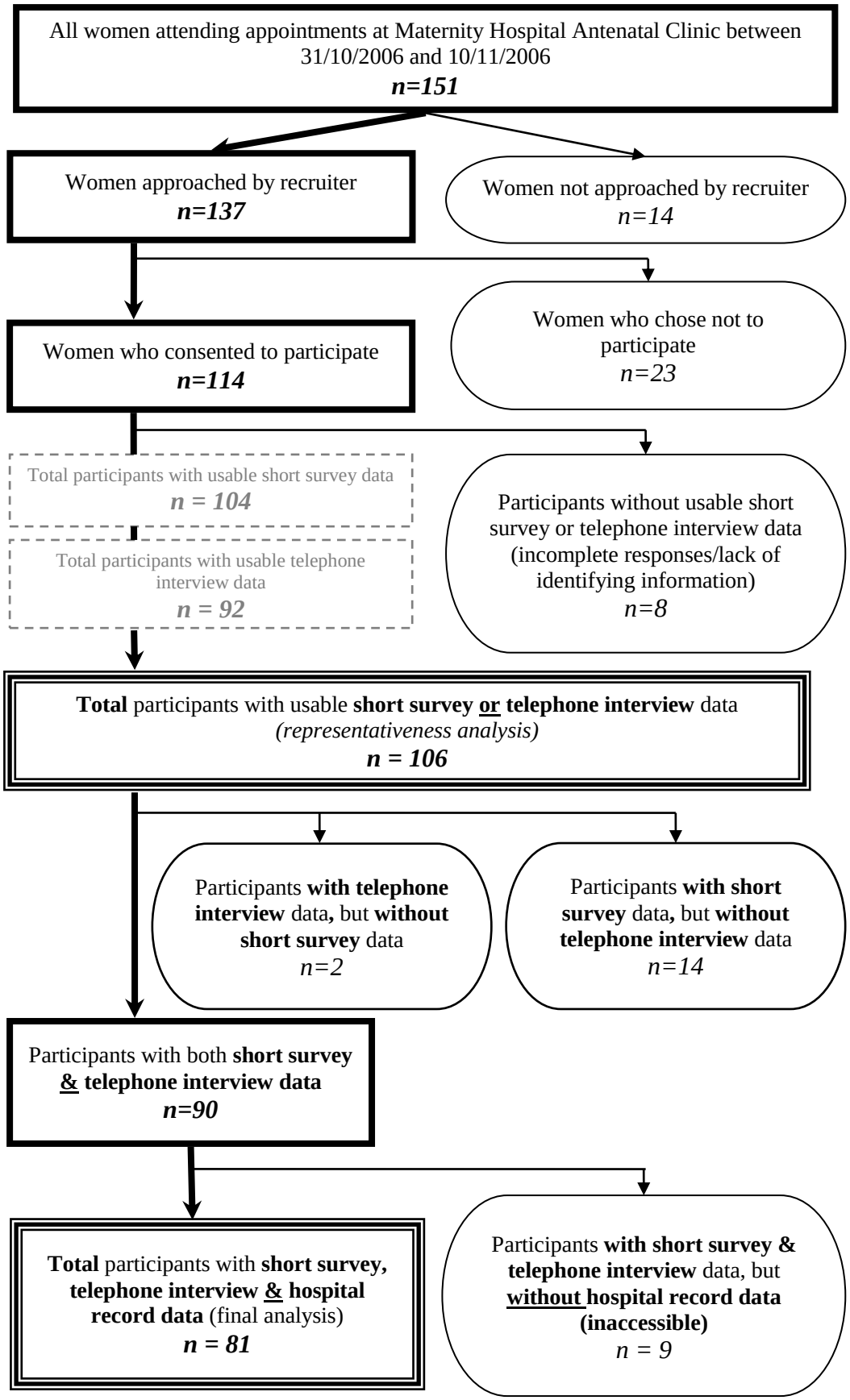

Figure 3.1: Flow of participants though recruitment and data collection process

3.5 DATA TREATMENT

Identifying information relating to participants was kept in a locked filing cabinet separate from participant response data. Access to the identifying information was limited to two research team members. Hospital identification numbers were used to match individual participant responses from different data collection methods.

Data were entered into Statistical Package for the Social Sciences (SPSS) version 16 and examined for coding errors, extreme values and inconsistencies by running descriptive statistical analyses for all variables. Queries and discrepancies were checked against original survey records and corrected.

3.6 DATA COLLECTION PROCEDURES

Data were collected via a short self-complete survey conducted at the antenatal clinic of a major maternity hospital and an interviewer-administered survey via a follow-up telephone conversation. Details of the measures used to assess dependent and independent variables in the survey and telephone interview will be discussed in sections 3.7.1 and 3.7.2. The survey and telephone interview questions used to capture potential covariate data will be outlined in Section 3.7.3. Full copies of the short survey and telephone interview are located in Appendices B and C (respectively).

In addition to the survey and interview, each participant's hospital medical records were later searched, to identify risk for domestic violence (during pregnancy) and provide details about health history and pregnancies. More details pertaining to hospital record data are provided in Section 3.7.3. This information was extracted from hospital records under the supervision of hospital staff and matched to questionnaires via the hospital identification numbers. A copy of the hospital data extraction sheet is located in Appendix D.

3.7 MEASURES AND DATA PREPARATION

The focus of this study was one dependent variable: depressive symptoms measured by the Hospital Anxiety and Depression Scale (HADS), and four

independent variables of interest: 'total activity', 'planned activity', 'total sitting time' and 'planned sitting time' measured by the Australian Women's Activity Survey (AWAS). As noted in Section 3.6, a number of additional variables were also captured by the data collection process for inclusion in the analysis as potential covariates. The following sub-sections describe the study measures and the processes used to prepare data for the dependent variable, independent variables and potential covariates.

3.7.1 DEPENDENT VARIABLE: DEPRESSIVE SYMPTOMS MEASURED BY THE HOSPITAL ANXIETY AND DEPRESSION SCALE (HADS-D)

Participant levels of anxiety and depression were assessed using the Hospital Anxiety and Depression Scale (HADS). A copy of HADS questions and scoring information is located in Appendix E. This 14 item scale is a self rating instrument consisting of two seven item subscales: one to assess anxiety (HADS-A), the other to assess depression (HADS-D). Both subscales are distinct from each other in a clinically meaningful way (Herrmann, 1997). Responses are scored from 0-3. Total subscale scores range from 0-21, with higher scores indicating increased anxiety or depressive symptoms. To avoid false positives from incorrectly attributing symptoms of physical conditions (as often observed during pregnancy) to anxiety or depression, HADS does not assess the physical indicators of psychological distress (Herrmann, 1997).

The original creators of HADS suggested that possible cases of depression be defined as scores of ≥ 8 and probable cases be defined as scores of ≥ 11, within both subscales (Zigmond & Snaith, 1983). When HADS is used in a clinical setting, the lower cut-point is recommended to avoid under-detection. A 2002 literature review by Bjelland, Dahl, Haug and Neckelmann found that in comparison with the DSM-III[1] obtained by clinical interview schedule, when a case criteria of ≥ 8 was used the sensitivity and specificity of the HADS-A were both approximately 0.9 and the sensitivity and specificity of HADS-D were also approximately 0.9 (Bjelland et al., 2002). Further, two-week test retest reliability indicated a high correlation ($r > 0.80$;

[1] The American Psychiatry Association's 'Diagnostic and Statistical Manual of Mental Disorders' is a well accepted source of classification and definition of mental illness. See section 2.1.1 of this document.

Herrmann, 1997). The HADS has also been validated for use among pregnant women with consistent results (acceptable sensitivity and specificity of 0.8 for the anxiety subscale and 0.9 for the depression subscale; Abiodun, 1994).

It has been suggested that the subscale scores from the HADS could be summed to create a score which indicates general psychological distress, despite the HADS' original authors advising against the use of such a measure (Crawford, Henry, Crombie & Taylor, 2001). However, in light of the other published literature also advising against the use of a total HADS score (Herrmann, 1997) and the fundamental focus of this thesis on depressive symptoms rather than general psychological distress; this study uses the HADS depression subscale score as the only dependent variable and acknowledges anxiety symptoms measured by the HADS anxiety subscale as a potential covariate.

Depressive Symptoms: Data Preparation

The HADS depression subscale (HADS-D) score was calculated by summing the seven depressive symptom items (Zigmond & Snaith, 1983). Data analysis in this study used the continuous HADS data because depressive symptoms are a dimensional rather than categorical construct (Bjelland, Lie, Dahl, Mykletun, Stordal & Kraemer, 2009), and the application of cut-points, whilst useful in a clinical context, can result in lost information, reduced power of statistical tests and increased probability of Type II error (Streiner, 2002).

A minimally important difference for HADS-D continuous data has not yet been universally established. One study based on a population of chronic obstructive pulmonary disease patients has established a minimally important difference as 1.5 points, using several anchoring approaches (Puhan, Frey, Büchi & Schünemann, 2008). Within health-related quality of life literature, a half standard deviation from the mean is regularly used to establish minimally important difference (Farivar, Liu & Hays, 2004). The criterion for minimally important difference in HADS-D scores for this study was therefore deemed to be one half of a standard deviation of the sample mean or two depression scale points, whichever was greater. It was considered preferable to err on the conservative side of an interpretation of results, which is why the greater of the two possible criterion values was used. Therefore,

although the minimally important value for this study was based on what was essentially an a priori decision, it was also informed by the above-mentioned studies and constrained by the application of the greater of two possible values.

3.7.2 INDEPENDENT VARIABLES: TOTAL ACTIVITY, PLANNED ACTIVITY, TOTAL SITTING AND PLANNED SITTING MEASURED BY THE AUSTRALIAN WOMEN'S ACTIVITY SURVEY (AWAS)

Participants' physical activity and sitting levels were assessed using the Australian Women's Activity Survey (AWAS; Fjeldsoe, Marshall & Miller, 2009). This interview-administered survey asks participants to recall the frequency and duration of a variety of physical activities and sitting behaviour, on week and weekend days during a typical week in the preceding month. AWAS was specifically developed to measure women's activity and time spent sitting, across the life domains in which Australian women typically operate (Collins, Marshall & Miller, 2007). The AWAS separates activity into the five domains of 'planned activities' (i.e., sport, recreation, leisure-time or exercise), 'employment', 'child care', 'domestic responsibilities' and 'transport', across the five intensity levels of sitting, brisk walking, light, moderate and vigorous.

The consensus in physical activity research is that moderate-to-vigorous intensity activity is required for health benefit, and that this level of intensity is achieved only in planned and transport contexts (Armstrong, Bauman & Davies, 2000). Therefore, although the AWAS measures all intensities of activity across all domains, only the totals for brisk walking and moderate–to-vigorous activity in the planned and transport domains are used when measuring physical activity that is associated with health benefit (Fjeldsoe, Marshall & Miller, 2009). Further, brisk walking is considered to be analogous to moderate-to-vigorous intensity activity only when it takes place in the planned and transport domains, so the AWAS measures brisk walking in these two domains only. Details relating to the domains and intensities measured by the AWAS are summarised in Table 3.1.

Table 3.1

AWAS measurement of activity intensity across multiple domains

Intensity ⇨ **Domain ⇩**	Sitting	Light Effort	Moderate Effort	Vigorous Effort	Brisk Walking
Planned	✓	✓	✓*	✓*	✓*
Employment	✓	✓	✓	✓	—
Childcare	✓	✓	✓	✓	—
Domestic	✓	✓	✓	✓	—
Transport	✓	✓	✓*	✓*	✓*

✓ Assessed by AWAS

— Not Assessed by AWAS

* Established Evidence Base Indicating Health Benefit

Data from the AWAS can be summed for each domain or each intensity level in minutes or days per week, by summing the data collected for weekdays and weekend days for the selected intensity level or activity domain. Summed data can be used to create compound categorical variables e.g. whether participants have attained a pre-determined number of both minutes and days of physical activity in a week.

The measurement properties of the AWAS have been tested against a motion-sensor instrument (accelerometer), amongst Australian women. For levels of physical activity known to be associated with health benefit (brisk walking and moderate–to-vigorous activity in the planned and transport domains), the test-retest reliability and validity have been established as: reliability coefficient = 0.80 (95% CI + 0.65 – 0.89) and validity coefficient = 0.28 (p = 0.01). For sitting, the AWAS test-retest reliability and validity have been established as: reliability coefficient = 0.42 (95% CI = 0.13 – 0.64) and validity coefficient = 0.32 (p = 0.006; Fjeldsoe, Marshall & Miller, 2009).

Physical Activity: Data Preparation

As noted previously in Section 2.6, the Australian physical activity guidelines (Egger, Donovan, Swinburn, Giles-Corti & Bull, 1999) and the U.S. Department of Health and Human Services (2008) recommend that pregnant women should do at

least 30 minutes of moderate-to-vigorous physical activity on most days of the week. This guideline is generally interpreted as ≥ 150 minutes across ≥ 5 days per week (Armstrong, Bauman & Davies, 2000). Cells marked with an asterisk in Table 3.1 indicate the specific intensities and domains of the AWAS that capture data relating to this guideline.

In light of these recommendations, the frequency of moderate, vigorous and brisk walking physical activity in the planned and transport domains were the main areas of interest in this study. Consequently, total weekly activity *minute*s and total weekly activity *days* were calculated for moderate, vigorous and brisk walking intensities, in the planned and transport domains. Vigorous activity minutes were weighted by two to account for the increased intensity relative to moderate physical activity (Armstrong, Bauman & Davies, 2000). The existing evidence base indicates that leisure-time and transport are the two contexts in which physical activity that is beneficial for health may take place (Armstrong, Bauman & Davies, 2000). In consideration of this, the first physical activity variable of interest for this study contained data from both the planned and transport domains. However, leisure-time (by itself) is a context that is commonly used in studies that have explored associations between physical activity and mental health (Teychenne, Ball & Salmon, 2008). Therefore, the second physical activity variable of interest for this study contained data from the planned domain only (without transport). Consequently, two continuous variables reflecting the total time that participants reported engaging in moderate and/or vigorous activity were created:

1. 'total activity minutes': the sum of brisk walking, moderate and vigorous intensity activity minutes accumulated in the *planned and transport domains* during a typical week
2. 'planned activity minutes': the sum of brisk walking, moderate and vigorous intensity activity minutes accumulated in the *planned domain only*, during a typical week

Similarly, the total number of days on which participants reported moderate and/or vigorous physical activity, were summed to create two continuous variables:

1. ‘total activity days’: the sum of brisk walking, moderate and vigorous intensity activity days accumulated in the *planned and transport domains* during a typical week
2. ‘planned activity days’: the sum of brisk walking, moderate and vigorous intensity activity days accumulated in the *planned domain only*, during a typical week

As current guidelines include both frequency and time components, compliance with the current physical activity guidelines was assessed by creating categorical variables. ‘Total activity days’ (frequency) was combined with ‘total activity minutes’ (time) and categorised into three groups according to Australian Government recommendations (Australian Institute of Health and Welfare, 2003) which are:

1. ‘sufficient’
   (moderate to vigorous activity ≥ 150 minutes and ≥ 5 days per week)
2. ‘insufficient’
   (0 < moderate - vigorous activity < 150 minutes and/or < 5 days per week)
3. ‘none’
   (moderate - vigorous activity = 0 minutes / days per week).

The resulting categorical variable to be used in subsequent analyses was called ‘<u>total activity category</u>’.

The same frequency and time criteria were applied to the ‘planned activity days’ (frequency) and ‘planned activity minutes’ (time) variables to define the categorical variable ‘<u>planned activity category</u>’.

Sitting: Data Preparation

Unlike physical activity, for which sufficient evidence exists to inform the categorisation of the data (Australian Institute of Health and Welfare, 2003; Armstrong, Bauman & Davies, 2000; U.S. Department of Health and Human Services, 2008), the sitting variables were treated as continuous data. Current research exploring associations between sitting and physical health outcomes has focussed on sitting time across all contexts and/or leisure-time sitting (using

television/screen-based entertainment as a proxy measure; Owen, Healy, Matthews & Dunstan, 2010), whereas research exploring associations between sitting and mental health has primarily focussed on leisure-time sitting, using the proxies noted above (Ussher, Owen, Cook & Whincup, 2007; Primack, Swanier, Georgiopoulos, Land & Fine, 2009). Congruent with these foci, two variables relating to reported sitting time were of interest in this study: 'total sitting time' and 'planned sitting time'. The time that participants reported sitting on week days and weekend days in each domain, were summed to calculate total sitting minutes for each domain. 'Total sitting time' was then calculated by summing total sitting minutes from all domains. 'Planned sitting time' was calculated by summing the time participants reported sitting in the planned domain. Totals were converted from minutes/wk to hours/wk for ease of reporting.

3.7.3 POTENTIAL COVARIATES: DEMOGRAPHIC, HEALTH, PREGNANCY AND DOMESTIC VIOLENCE DATA FROM SURVEY, INTERVIEW AND HOSPITAL RECORDS

The risk factors for depression during pregnancy (excluding the independent variables) that were identified in Section 2.5.1 were considered for inclusion as potential covariates in regression analyses. Potential covariate data were captured by questions in the short survey and telephone interview, and from hospital medical records.

A number of questions from the short survey and telephone interview aimed to establish each participant's demographic characteristics. These included age, income, education, ethnicity and partner status. These variables are important indicators of exposure to risks such as being pregnant at a young age, low socioeconomic status and single motherhood (Ryan, Milis & Misri, 2005; Lancaster, Gold, Flynn, Yoo, Marcus & Davis, 2010). Questions about past and current pregnancies (live births, terminations and intentions to fall pregnant with current baby) were included as indicators of exposure to risks such as a high number of previous abortions, unplanned pregnancy and higher numbers of existing children (Ryan et al, 2005; Bowen & Muhajarine, 2006). Questions about physical and mental health (smoking and alcohol consumption, health service usage and past diagnoses) were included as indicators of exposure to risks such as drug/alcohol abuse and pre-existing physical or mental illnesses (Lancaster et al, 2010; Maloni, Kane, Suen, &

Wang, 2002; Bennett, Einarson, Taddio, Koren & Einarson, 2004; Bowen & Muhajarine, 2006). Further questions relating to physical activity (changes in activity levels since becoming pregnant, preferences for physical activity, incidental activity choices and social support for physical activity) were asked to provide some background information about participants' attitudes and practices relating to physical activity and to provide additional depth to AWAS data.

In addition, information on domestic violence, health background and previous pregnancies was extracted from each participant's hospital medical records. A domestic violence questionnaire completed by hospital staff prior to admission included questions on participant exposure to physical and psychological violence during their pregnancy. The list of the domestic violence questions asked by hospital staff is included in Appendix F. This information was important to the present study because domestic violence is a known risk factor for depression during pregnancy (Lancaster et al, 2010). Information on previous health issues and pregnancies was extracted from hospital records as a means of providing data in circumstances where participants had not answered such questions in the short survey and telephone interview. As already stated, information on health background and previous pregnancies can be an indicator of participant exposure to risks such as previous abortions, number of existing children and pre-existing physical or mental health issues (Ryan et al, 2005; Bowen & Muhajarine, 2006; Lancaster et al, 2010). A list of all covariates included in statistical analyses is presented in Table 4.4.

Demographic, Health, Pregnancy and Domestic Violence: Data Preparation

Each participant's age and the ages of their existing children were calculated by deducting the respective dates of birth from the date of the survey. The number of existing children borne by each participant was also calculated by summing the number of existing children's birthdates provided by each participant.

Marital status, education and income were reduced to two categories due to the small numbers of participants in some of the original categories. Marital status was reduced by combining the responses "married" and "de facto" into a single category and "never married", "separated", "divorced" and "widowed" into a single category. Education was reduced by combining the responses "no formal education" and "year

10 or 12 equivalent" into a single category and "trade/apprenticeship or certificate/diploma" and "university degree or higher" into a single category representing post secondary school education. Income was reduced by combining all responses between $0 and $25,999 into a single category to represent low income and all responses of $26,000 and above into a single category.

Health data relating to medical conditions were dichotomised according to whether each participant reported that they had ever been diagnosed, or never been diagnosed, with diabetes (any type), depression, postnatal depression, anxiety, hypertension, high cholesterol and eating disorders (anorexia or bulimia). Smoking data were also dichotomised according to whether participants reported that they currently smoked or did not currently smoke and whether they reported they had ever smoked or never smoked. Alcohol intake was dichotomised according to whether each participant reported high (greater than two standard drinks per day) or low risk alcohol intake (NHMRC, 2009) before pregnancy, and whether they reported high or low risk alcohol intake since they became pregnant. Changes in physical activity since becoming pregnant were dichotomised according to whether each participant reported reductions in activity since becoming pregnant or whether they reported the same level or a higher level of activity since becoming pregnant.

Pregnancy data were used as a continuous variable indicating the number of existing children reported by each participant.

Domestic violence data were categorised dichotomously according to whether each participant responded 'yes' or 'no' to domestic violence questions asked during their initial visit to the hospital antenatal clinic (see Appendix F).

3.7.4 POTENTIAL COVARIATE: ANXIETY SYMPTOMS MEASURED BY THE HOSPITAL ANXIETY AND DEPRESSION SCALE (HADS-A)

The HADS anxiety subscale was used to measure anxiety symptoms among participants, as depression and anxiety are often comorbid (Skouteris, Wertheim, Rallis, Milgrom & Paxton, 2009). Details about the sensitivity and specificity of the HADS were reported in Section 3.7.1. Total anxiety subscale scores can be used as continuous data or reduced to a categorical representation of 'not-at-risk' (< 8) or 'at-risk' (≥ 8) according to the threshold indicated by Bjelland et al. (2002).

Anxiety Symptoms: Data Preparation

Each item on the HADS was scored from 0-3 using the instrument scoring criteria. The HADS anxiety subscale score was calculated by summing the seven anxiety symptom items (Zigmond & Snaith, 1983). While the total anxiety subscale scores can be reduced to categorical data, this study used the continuous HADS data because anxiety is a dimensional construct (Bjelland et al, 2009), and the application of cut-points, whilst useful in a clinical context, can result in lost information, reduced power of statistical tests and increased probability of Type II error (Streiner, 2002).

3.7.5 POTENTIAL COVARIATE: SOCIAL SUPPORT MEASURED BY THE MATERNITY SOCIAL SUPPORT SCALE

The Maternity Social Support Scale is a six item self report instrument with a five-point likert response range and intended to measure social support resources for pregnant women. Total scores range from 6-30, with higher scores indicating higher levels of support. Based on a pilot study, scores can be categorised into low (0-18), medium (19-24) and adequate (≥ 25) social support (Webster, Linnane, Dibley, Hinson, Starrenburg & Roberts, 2000, p. 99). See Appendix G.

It was important to include this measure in the study since low scores on the maternity social support scale have been significantly associated with poorer health during pregnancy ($p < 0.01$) and increased risk for perinatal depression ($p<0.001$; Webster et al., 2000). The reliability and validity of this scale is not available in the literature.

Social Support: Data Preparation

Each item on the maternity social support scale was scored from 1-5 using the instrument scoring criteria. A total maternity social support scale score was calculated by summing all individual item scores. Social support scores can be used as continuous data or categorical data; however, in this study maternity social support scale scores were used as continuous data for similar reasons to those noted in Sections 3.7.1 and 3.7.4.

3.8 STATISTICAL ANALYSES

All data in this study were analysed using SPSS for Windows version 16.0. Results were considered significant at $p \leq 0.05$, with two exceptions. The first exception was the significance value required for a potential covariate to be included in linear regression analyses, where the criterion was set at $p \leq 0.2$ to ensure no potential relationships were overlooked (Vittinghoff, Glidden, Shiboski & McCulloch, 2005, p.153). The second exception was the significance value deemed to indicate a trend. As indicated by Wood (2001), p-values between 0.05 and 0.1 may be assumed to indicate a strong trend, as it is "unlikely that these results were the result of chance" (p. 75). In this study, therefore, a p-value > 0.05 and < 0.07 was the criterion used to determine whether a statistical trend existed between sitting variables and depressive symptoms, justified by the exploratory nature of sitting-based research. The relationships between the dependent (depressive symptoms) and independent (physical activity and sitting) variables in this study were analysed using hierarchical multivariable linear regression. This process is further described in Section 3.8.4, but before that, data preparation and management processes are described.

3.8.1 ASSUMPTIONS OF STATISTICAL ANALYSIS METHODS

Normality

Continuous data were tested for normality to ensure that the correct summary statistics were reported and the correct statistical analyses were performed. Descriptive statistics were produced for all continuous variables and a normal distribution curve was overlaid on a frequency distribution histogram of the data. An assumption of normality was made if the following criteria were met:

1. Mean within 10% of the median value
2. Mean ± 3 standard deviations close to minimum and maximum values
3. Histogram approximated an overlay of a normal distribution curve
4. Skewness and kurtosis coefficients both between –3 and +3

The above criteria aim to assess symmetry and dispersion to ensure that means are a sound measure of central tendency and that standard deviations appropriately reflect dispersion (personal communication, D. Battistutta, 29/10/2008).

Where continuous data were normally distributed, the mean and standard deviation were reported and parametric tests were used for analysis. Where continuous data were not normally distributed, the medians and inter-quartile ranges are reported and non-parametric tests were used for analysis. Where continuous independent variable data in the regression analysis were not normally distributed, the residuals were checked to ascertain that they approximated normality, eliminating the need for further manipulation of the data (e.g., log transformations).

Homogeneity of Variance and Equal Sample Size

Where data were compared using t-tests, the significance value of Levene's test for equality of variances was taken into account prior to reporting results. Where Levene's $p > 0.05$, the 'equal variances assumed' test statistic and significance value were reported. Where Levene's $p \leq 0.05$, the 'equal variances not assumed' test statistic and significance value were reported. Where data were compared using ANOVAs, the significance value of Levene's test for equality of variances was taken into account prior to reporting results. Where Levene's $p > 0.05$, the initial ANOVA result and significance value were reported. Where Levene's $p \leq 0.05$, the Brown-Forstyth homogeneity of variance test statistic and significance were reported. Where homogeneity of variance could not be assumed and sample sizes were not approximately equal, the Games-Howell ad hoc test was used. Where data were included in a regression model, residuals were saved and plotted. Additional data manipulations such as log transformations were not required, as the residuals for non-normally distributed continuous data approximated normality and displayed constant variance.

Linear Relationship

Continuous independent variables (i.e., total sitting and planned sitting) and continuous covariates were checked to confirm that any observed relationship with the dependent variable (depressive symptoms) was linear, using scatter plots of the independent variable/covariate against the dependent variable. Additional

confirmation was obtained for sitting variables due to their non-normal distribution, using plots of actual versus predicted residual values. Covariate plots can be found in Appendix G and sitting variable plots can be found in Appendix I.

Ratio of Cases to Independent Variables

Linear regression analysis assumes that the ratio of the cases to the independent variables is at least 5:1 and preferably 15:1, as low case-independent variable ratios can lead to non-parsimonious predictions that explain very little (Osborne & Costello, 2004). This study has a relatively small sample size, leading to a case-independent variable ratio of between 4.8:1 and 5.1:1. Thus the results of the final analysis should be interpreted with caution.

Multicollinearity

The variance inflation factor (VIF) statistic from all regression models was used as an indicator of any issues resulting from collinearity between model variables. Where the VIF statistic ≤ 2 (Peat, Barton & Elliott, 2008, p. 104), it was assumed that there was no negative impact on the analysis due to collinearity.

3.8.2 ANALYSIS OF DEMOGRAPHIC CHARACTERISTICS

To gain an understanding of the sample characteristics, descriptive statistics were produced for demographic data. All continuous data were approximately normally distributed and therefore were reported using mean and standard deviation as summary statistics. Categorical variables were reported according to the number of participants and percentages in each category.

The entire study sample (n = 106) was compared with Queensland census data and Australian Institute of Health and Welfare 'Mothers and Babies' data (Laws & Sullivan, 2009) on women living in Queensland to check the representativeness of study participants; however, final analyses included only 81 of the total 106 participants. This was due to the loss of 25 women who did not complete the short survey or did not complete the telephone interview or did not have accessible hospital records. The demographic characteristics of the final sample of 81 were compared to the 25 participants who were lost due to missing data, to establish

whether the two groups differed in any significant manner. By implication, if all study participants were broadly representative of a Queensland sample and no significant differences existed between participants lost due to missing data and the final sample, then the final sample could be said to be broadly representative of Queensland women. Figure 3.1 shows how the flow of participants through the recruitment process led to the final sample.

3.8.3 ANALYSIS OF PHYSICAL ACTIVITY AND SITTING CHARACTERISTICS

A preliminary analysis was completed for physical activity and sitting data and descriptive statistics were reported. Categorical physical activity data measuring compliance with Australian guidelines were reported according to the number of participants and percentages in each category. Continuous data relating to participants' sitting behaviour was reported using median and interquartile ranges, as the data did not meet normality criteria relating to mean/median and dispersion. Mean depressive symptom scores (HADS-D) were reported for physical activity categories and sitting data quartiles. As discussed in Section 3.8.2 and indicated by Figure 3.1, the sample for this analysis (n = 81) was smaller than the original sample (n = 106), due to the loss of 25 participants who did not complete the short survey or did not complete the telephone interview or did not have accessible hospital records.

3.8.4 HIERARCHICAL MULTIVARIABLE LINEAR REGRESSION

Hierarchical multivariable linear regression was the primary method of analysis used to explore relationships between the independent and dependent variables in this study. Sample size for this analysis was 81 due to missing data from 25 of the original participants as discussed in Section 3.8.2 and indicated by Figure 3.1. Potential covariates were identified by conducting a bivariate comparison of every study variable with the dependent variable (depressive symptoms). Pearson's correlation (for normally distributed data) or Spearman's Rho (for data that was not normally distributed) were used for continuous independent variables; and t-tests (for two-category variables) or ANOVA's (for variables with more than two categories) were used for categorical independent variables. Scatter plots used to confirm the linearity of observed relationships are included in Appendix H. Variables that

returned significance levels of $p \leq 0.2$ in the bivariate analysis were considered as having a potential relationship with the dependent variable (depressive symptoms) and were therefore noted. The justification for using this significance value is discussed in Section 3.8. Each noted variable was then assessed for empirical evidence indicating an association with depression in pregnancy.

Table 3.2 lists all the variables that met the bivariate analysis significance criteria of $p \leq 0.2$ and indicates which of these variables could be included or excluded for the regression analyses. Initially, three potential covariates were excluded because no literature exploring their association with depression during pregnancy was available in the evidence base. These were 'household configuration', 'participant ever diagnosed with an eating disorder' and 'reduced physical activity since pregnant'. A further five potential covariates were excluded due to one of their categories containing two (2) or fewer participants, which would have rendered meaningless any statistical conclusions based on their results. These were the domestic violence indicators of 'participant ever afraid of partner', 'participant hit/kicked/punched at home in last year' and 'participant threatened with harm by partner in last year', and the health and lifestyle variables 'participant stated postnatal depression after birth of 3rd child' and 'high risk alcohol intake since pregnant'. As indicated by Table 3.2, the 14 potential covariates that met all the criteria for inclusion in the regression analyses were: 'gross household income', 'education status', 'gross individual income', 'partner status', 'number of terminations', 'planned pregnancy', 'problems falling pregnant', 'number of existing children', 'maternity social support scores', 'partner put down/humiliated participant', 'HADS anxiety score', 'participant ever diagnosed with depression', 'current smoker' and 'high-risk alcohol intake prior to pregnancy'.

Additional details relating to significance of the bivariate associations observed between potential covariates and the dependent variable (depressive symptoms) are reported as results in Section 4.3.

The independent variables are the focus of this investigation and were therefore not subject to bivariate significance criteria to justify their inclusion in the modelling process. However, continuous independent variables were checked to confirm that any observed relationship with the dependent variable (depressive symptoms) was linear.

Details of statistically significant relationships between independent variables (physical activity and sitting) and the dependent variable (HADS-D scores) are reported as results in Table 4.4.

Table 3.2

Potential covariates considered for multivariable linear regression models

Bivariate analysis with independent variable indicated p ≤ 0.2	Association with depression during pregnancy in literature	Included in regression
1. Demographic information		
Gross household Income	Inconsistent (SES)	Yes
Education Status	Inconsistent (SES)	Yes
Gross Individual Income	Inconsistent (SES)	Yes
Partner Status	Yes	Yes
Household configuration	No literature	No
2. Pregnancy & Childbirth		
Number of pregnancy terminations	Yes	Yes
Pregnancy was planned	Yes	Yes
Problems falling pregnant	Yes	Yes
Number of existing children	Yes	Yes
3. Social Environment		
Maternity Social Support Scores	Yes	Yes
Hospital Record Indicators of Domestic Violence		
Participant put down/humiliated at home in last year	Yes	Yes
Participant ever afraid of partner	Yes	No[a]
Participant hit/kicked/punched at home in last year	Yes	No[a]
Participant threatened with harm by partner in last year	Yes	No[a]
4. Health & Lifestyle		
HADS anxiety score	Yes	Yes
Participant ever diagnosed with depression	Yes	Yes
Current Smoker	Yes	Yes
High risk alcohol intake prior to pregnancy	Yes	Yes
Participant stated postnatal depression after 3rd child	Yes	No[a]
Participant ever diagnosed with an eating disorder	No literature	No
High risk alcohol intake since pregnant	Yes	No[a]
Reduced physical activity since pregnant	Aspect of thesis focus	Yes

[a] Participants in 'yes' category ≤ 2

Analysis using multivariable linear regression requires variables to be continuous or dichotomous. Continuous variables and dichotomous categorical variables therefore required no further preparation for regression; however, some manipulation was required to prepare variables that did not meet these criteria. The 'total activity category' and 'planned activity category' independent variables both contained three categories, 'sufficient', 'insufficient' and 'none'. Each of these single variables required conversion into two dichotomous dummy variables, with the 'none' category used as the referent group. As a result, the categorical variable 'total activity category' was transformed into two dichotomous variables, 'sufficient

activity (Yes/No)' and 'insufficient activity (Yes/No)'. Similarly, the categorical variable 'planned activity category' was transformed into two dichotomous dummy variables, 'sufficient planned activity (Yes/No)' and 'insufficient planned activity (Yes/No)'.

The use of the 'none' category as the constant (referent group) against which the other two alternatives (sufficient and insufficient) were compared allowed subsequent analysis to indicate whether any activity is important with regards to depression during pregnancy OR whether only 'sufficient' activity is important.

The 'alcohol consumption prior to pregnancy' covariate was transformed into the dichotomous variable 'high risk alcohol consumption prior to pregnancy (Yes/No)' based on the National Health and Medical Research Council (NHMRC) guidelines (2009) of no more than 2 standard drinks on any one day.

A total of eight regression analyses were completed. The first four regressions included all the potential covariates plus one of the physical activity variables (represented by two dichotomous dummy variables) *or* one sitting variable of interest. Regressions five and six included the same potential covariates in addition to one physical activity variable (represented by two dichotomous dummy variables) *and* one sitting variable of interest. The regressions with either physical activity *or* sitting variables explored only potential relationships with the dependent variable, whereas regressions that included both physical activity *and* sitting variables also explored potential relationships between physical activity and sitting constructs in relation to the dependent variable. Variables were introduced to the regression analyses in blocks. The stepwise method was used for all covariates, with a probability of F entry value of 0.05 and removal value of 0.1. Covariates were entered into regression analyses first, before independent variables. Covariates were ordered within each block according to their significance values in the bivariate analysis, from lowest to highest significance. Blocks were ordered approximately according to the covariate of highest significance; apart from demographic information which, by convention, was placed in block one. The independent variables of interest (reported time in physical activity and sitting) were forced into their respective models last, using the enter method.

In the first regression analysis the dummy variables representing 'total activity' were the only variables in the final block (block 5). These were replaced in the second analysis by the dummy variables representing 'planned activity'. The physical activity dummy variables were replaced in the third and fourth analyses with the continuous sitting variables 'total sitting time' and 'planned sitting time', respectively.

In regression five, the dummy variables representing 'total activity' were entered into block five and 'total sitting time' was entered into block six. In regression six, the dummy variables representing 'planned activity' were entered into block five and 'planned sitting time' was entered into block six.

Although it is acknowledged that the six regression models that form the basis of this study could be subjected to multiple test adjustments such as the Bonferroni procedure, the study significance criteria was left at $p \leq 0.05$ for this initial look at the correlates of depression during pregnancy. This decision was based on the exploratory nature of the study (Bender & Lange, 2001). To subject this exploratory data to the more stringent tests of significance that may be required for a study such as a clinical trial, runs the risk of discouraging other investigators from examining potentially important relationships leaving avenues of enquiry that may later prove to be fruitful, overlooked.

3.8.5 ADDITIONAL ANALYSES

In addition to the six regression models outlined in Section 3.8.4, additional analyses were conducted to evaluate potential interaction between physical activity and sitting variables, and to determine which combination of covariates and independent variables created the most parsimonious models.

Interaction

Two analyses were conducted to identify any joint effect of the independent variables over and above their main effects (i.e., interaction; Robinson & Schumacker, 2009). The first interaction analysis focussed on potential interaction between 'total activity' and 'total sitting' variables. The continuous 'total sitting' data was centred on a mean of zero by deducting the sample mean from all data

points. The dummy variables for ‘total activity’ were left in their raw state (University of Connecticut, n.d. para. 8). The centred ‘total sitting’ variable and the ‘total activity’ dummy variables were then used to create two new variables ‘sufficient total activity (Yes/No) multiplied by total sitting’ and ‘insufficient total activity (Yes/No) multiplied by total sitting’ (University of Connecticut, n.d. para. 11). A new regression in which all potential covariates were included in blocks one to four using the ‘stepwise’ method described in Section 3.8.4, the total activity (dummies) and total sitting variables were forced into block five using the ‘enter’ method, and the two new ‘total’ interaction variables were forced into block six using the ‘enter’ method, was run.

The second interaction analysis focussed on potential interaction between ‘planned activity’ and ‘planned sitting’ variables. Exactly the same preparation processes that were used to explore the potential interaction between the total activity and total sitting variables were used to prepare planned activity dummy variables and the planned sitting variable for the second interaction analysis. The new variables were then used to run a regression model in which all potential covariates were included in blocks one to four using the ‘stepwise’ method described in Section 3.8.4, the planned activity (dummies) and planned sitting variables were forced into block five using the ‘enter’ method, and the two new ‘planned’ interaction variables were forced into block six using the ‘enter’ method.

Nesting

Based on results from the original six regression analyses that indicated a significant association between total activity and depressive symptoms in models one and five, and a trend toward a significant correlation between planned sitting and depressive symptoms in models four and six; two final analyses were conducted to determine the most parsimonious combination of covariates and independent variables.

The first of the nesting analyses evaluated whether removing ‘total sitting’ from regression model five improved the parsimony of this model. A regression in which all potential covariates were included in blocks one to four using the ‘stepwise’ method described in Section 3.8.4, the total activity (dummies) and total

sitting variables were forced into block five using the ‘enter’ method and the total sitting variable was included in block six with the instruction to ‘remove’, was run (University of Northern Iowa, n.d.).

The second nesting analysis aimed to evaluate whether removing ‘planned activity’ from regression model six improved the parsimony of this model. A regression model in which all potential covariates were included in blocks one to four using the ‘stepwise’ method described in Section 3.8.4, the ‘planned activity (dummies) and planned sitting variables were forced into block five using the ‘enter’ method, and the planned activity dummy variables were included in block six with instructions to ‘remove’, was run.

The statistical analyses of the bivariate comparison, the multivariable linear regressions, and the interaction and nesting analyses are reported in Section 4.3. However, the results section will begin by reporting on the demographic characteristics and representativeness of the study sample.

Chapter 4: Results

4.1 SAMPLE CHARACTERISTICS

4.1.1 REPRESENTATIVENESS OF SAMPLE

Comparisons of different data sets are fraught with difficulty due to differences in the type of data collected and the cut-points used to differentiate categories. In the best attempt to ensure the study sample was representative, demographic characteristics of all participants with usable short survey or telephone interview data (n = 106) were compared with Queensland-wide demographic data for women reported by the Australian Bureau of Statistics (2007) and Queensland birthing data published by the Australian Institute of Health and Welfare (Laws & Sullivan, 2009). The comparison with Queensland birthing data indicated that the current study under-represented older women (36+ years 13.5% versus 19.2%) and Aboriginal/Torres Strait Islander women (3.9% versus 5.4%). The comparison with Queensland-wide demographic data indicated that the current study under-represented women with household incomes below $26,000 per annum (5.4% versus 11.6%), and over-represented partnered women (86.5% versus 59.1%) and women speaking only English at home (93.8% versus 86.6%).

The study sample can be considered broadly representative of women living in Queensland, Australia.

4.1.2 DEMOGRAPHIC PROFILE OF SAMPLE

The sample used in the final analysis included the 81 participants with data from all sources (the short survey, telephone survey and hospital records). To ensure that the final analytic sample did not differ significantly from the larger original sample from which it was drawn, the demographic characteristics of those with and without data from all-sources were compared using Fisher's exact test on categorical variables and t-tests on continuous variables. No significant differences ($p < 0.05$) were found. Therefore, the analytic sample can be considered representative of the

sample from which it came. Table 4.1 illustrates the demographic characteristics of the two groups.

As indicated by Table 4.1, descriptive analysis of the final sample indicated that participants were aged between 18 and 40 years (mean age = 29.5 ±5.6 years), with 24 participants (29.6%) aged between 26 and 30 years and 22 (27.2%) aged between 31 and 35 years. The sample included 70 partnered participants (86.4%). Three participants (3.7%) identified themselves as Indigenous or Torres Strait Islander. English was the only language spoken in the households of 76 participants (93.8%). Post secondary education or training was reported by 50 participants (61.7%).

Most participants (82.7%) were in the second trimester of their pregnancy and 41 participants (50.6%) were living with their child(ren) only. The sample included 19 participants (23.5%) who had been born overseas and five participants (6.2%) who reported an income of below $26,000 per annum for their household. There were 42 participants (51.9%) in paid employment at the time of the survey and two participants (2.5%) who were unemployed and looking for work. All demographic characteristics of the final sample and of those participants who were missing from the final sample are included in Table 4.1.

Table 4.1

Demographic characteristics of study sample (n = 106)

Demographic Variable	Participants with data from all sources n = 81	Participants missing data from one or more sources n = 25
	Mean (SD, Range) or n (%)	*Mean (SD, Range) or n (%)*
Age (years)[a]	29.5 (5.6, 22)	27.4 (5.6, 24)
≤ 20 years	5 (6.2%)	2 (8%)
21-25 years	17 (21%)	6 (24%)
26-30 years	24 (29.6%)	10 (40%)
31-35 years	22 (27.2%)	6 (24%)
≥ 36 years	13 (16%)	1 (4%)
Marital Status[b]		
Partnered	70 (86.4%)	20 (80%)
Not partnered	11 (13.6%)	3 (12%)
Missing	–	2[d] (8%)
ATSI Status[a]		
Aboriginal or Torres Strait Islander	3 (3.7%)	1 (4%)
Neither	78 (96.3%)	22 (88%)
Missing	–	2[d] (8%)
Language spoken at home[b]		
English and/or other	3 (3.7%)	1 (4%)
English	76 (93.8%)	22 (88%)
Missing	2[c] (2.5%)	2[d] (8%)
Highest Educational Qualification[b]		
No formal qualification; year 10/ 12	31 (38.3%)	12 (48%)
Apprenticeship, certificate, diploma, university degree or higher	50 (61.7%)	11 (44%)
Missing	–	2[d] (8%)
Trimester		
First Trimester	1 (1.2%)	1 (4%)
Second Trimester	67 (82.7%)	21 (84%)
Third Trimester	12 (14.8%)	1 (4%)
Missing	1[c] (1.2%)	2[d] (8%)
Participant Living Arrangements[b]		
Living with partner/ spouse only	1 (1.2%)	–
Living with partner/ spouse & child(ren)	26 (32.1%)	4 (16%)
Living with child(ren) only	41 (50.6%)	6 (24%)
Living with other adults (no children)	4 (4.9%)	1 (4%)
Living with own parents (with/without brothers & sisters)	2 (2.5%)	–
Other	1 (1.2%)	–

Table Continued on Next Page

Demographic Variable	Participants with data from all sources n = 81	Participants missing data from one or more sources n = 25
	Mean (SD, Range) or n (%)	*Mean (SD, Range) or n (%)*
Missing/Refused to answer	6[a] (7.4%)	14[e] (56%)
Country of Birth[a]		
Australia	62 (76.5%)	8 (32%)
Other	19 (23.5%)	3 (12%)
Missing/ Don't know/ Refused to answer	–	14[e] (56%)
Gross Individual Income		
$0 - $25999 annually	44 (54.3%)	7 (28%)
$26000 or more annually	34 (42%)	4 (16%)
Missing/ Don't know/ Refused to answer	3[c] (3.7%)	14[e] (56%)
Gross Household Income[b]		
$0 - $25999 annually	5 (6.2%)	–
$26000 or more annually	72 (88.9%)	11 (44%)
Missing/ Don't know/ Refused to answer	4[c] (4.9%)	14[e] (56%)
Employment Status[b]		
Home duties only (no paid work)	35 (43.2%)	6 (24%)
Full time paid work	22 (27.2%)	3 (12%)
Part time/ casual paid work	20 (24.7%)	1 (4%)
Work without pay (e.g. in family business)	1 (1.2%)	–
Unemployed – looking for work	2 (2.5%)	–
Other	1 (1.2%)	1 (4%)
Missing/ Don't know/ Refused to answer	–	14[e] (56%)

[a] Australian Institute of Health and Welfare (Laws & Sullivan, 2009)
[b] Australian Bureau of Statistics (2007)
[c] Question Not Answered
[d] All Short Survey Data Missing
[e] All Telephone Interview Data Missing

4.2 DESCRIPTIVE ANALYSIS OF DEPRESSIVE SYMPTOMS, PHYSICAL ACTIVITY AND SITTING VARIABLES

HADS depressive symptom scores ranged between 3 and 17, with a mean of 6.38 and a standard deviation of 2.55. The distribution met the normality criteria described in Section 3.8.1, despite a slight positive skew. As a half standard deviation of HADS depressive symptom scores was only 1.28 points, the criteria for

clinically meaningful difference in HADS depressive symptom scores was hereafter established as 2 points (see Section 3.7.1).

The 'total activity category' variable summarised physical activity data from the combined planned and transport domains of AWAS. Most participants (71.6%) were engaging in no moderate-to-vigorous activity or insufficiently active in a typical week, with only 23 participants (28.4%) reporting that they were meeting guidelines[2] for physical activity.

Physical activity data from the planned domain only (leisure-time) were indicated by the 'planned activity category' variable. A substantial proportion (84%) of participants reported less than sufficient levels of physical activity in a typical week, and 46 participants (56.8%) reported that they were engaging in no moderate-to-vigorous activity at all during their leisure-time.

Total sitting time ranged between 3.5 and 92.0 hours per week. The distribution was positively skewed and the minimum value (3.5) differed substantially from the mean less 3 standard deviations (-20.1). As a result, total sitting time did not meet the criteria for normality stated in Section 3.8.1. The median was 33.25 hours.

Similarly to total sitting time, the planned sitting time distribution was positively skewed and failed to meet normality criteria relating to minimum and maximum values. Planned sitting time ranged between 0 and 56 hours per week with a median value of 15 hours.

Table 4.2 summarises the univariate analysis of the dependent and independent variables. Histograms of the HADS depression scores, total sitting time and planned sitting time distributions are located in Appendix I.

[2] Moderate-Vigorous Physical Activity of 150 or more minutes per week on 5 or more days per week

Table 4.2

Results for univariate analysis of dependent and independent study variables

Variable	Mean (SD, Range); n (%) or Median (IQR, Range)
Dependent Variable	*Mean (SD)*
HADS Depressive Symptom Scores	6.38 (2.55, 14)
Independent Variables (Categorical)	*n (%)*
Total Activity Category	
None	30 (37%)
Insufficient	28 (34.6%)
Sufficient	23 (28.4%)
Planned Activity Category	
None	46 (56.8%)
Insufficient	22 (27.2%)
Sufficient	13 (16%)
Independent Variables (Continuous)	*Median (IQR, Range)*
Total Sitting Time (hrs/wk)	33.25 (26.1, 88.5)
Planned Sitting Time (hrs/wk)	15 (14.5, 56)

4.3 EXPLORATORY ANALYSIS OF THE POTENTIAL RELATIONSHIP BETWEEN DEPRESSION, SUFFICIENT PHYSICAL ACTIVITY AND SITTING

4.3.1 BIVARIATE ANALYSIS OF INDEPENDENT VARIABLES AND POTENTIAL COVARIATES IN RELATION TO DEPENDENT VARIABLE

Physical Activity & Sitting

ANOVA's were conducted to analyse the differences between physical activity data categories in relation to depressive symptom scores. Statistically significant differences were observed between 'total (planned and transport domains) activity' categories on mean depression scores ($F = 6.7$, $p = 0.002$). The mean HADS-D score for the sufficient category was 2.2 points lower than that for the 'none' category, which meets the criteria of minimally important difference as noted in Section 4.2.

There were also statistically significant differences observed between 'planned activity categories' on mean depression scores ($F = 3.9$, $p = 0.02$). The sufficient category again had the lowest mean depressive symptom score, which was 1.7 points lower than the 'none' category. This was the largest of the observed differences between planned activity categories; however, it did not meet the criteria for minimally important difference.

Preliminary linear regressions were conducted to identify and confirm the linearity of any observed relationships between continuous sitting data and depressive symptom scores. 'Total (all domains) sitting' hours/wk was not significantly associated with depressive symptom scores ($F = 0.77$, $p = 0.38$). The increase in HADS-D scores associated with each additional hour of total sitting was 0.10 points, indicated by the standardised beta value. This did not meet the criteria for minimally important difference. A scatter plot indicated no relationship (linear or non-linear) between the variables, and this was confirmed by a plot of the standardised residuals as a function of the standardised predicted values (Appendix I).

'Planned sitting' hours/wk was significantly associated with depressive symptom scores ($F = 4.42$, $p = 0.04$). The increase in HADS-D scores associated with each additional hour of planned sitting was 0.23 points, indicated by the standardised beta value. This did not meet the criteria for minimally important difference. A scatter plot indicated that this relationship was linear, and this was confirmed by a plot of the standardised residuals as a function of the standardised predicted values (Appendix J).

Table 4.3 summarises the results of the bivariate analyses of the relationships between the independent variables and depressive symptom scores. Significant bivariate results were observed for the 'total activity', 'planned activity' and 'planned sitting' variables. The contribution of sitting variables to explained variance (r^2 value) is not reported in Table 4.3, but this is explored in Section 4.3 in conjunction with the contribution of potential covariates. Appendix I contains the scatter plots used to confirm linearity of relationships between continuous independent variables and depressive symptom scores.

Table 4.3

Differences in depressive symptom scores (HADS-D) relating to independent variables (Physical Activity and Sitting)

Independent Variable	Mean (SD) HADS Score for Categorical Data	Difference in mean HADS Score *or* Standardised Beta	F Statistic *(p-value)*	Clinically Meaningful
Physical Activity (Categorical Data)		*Difference in Mean*		
Total Activity			6.70 *(0.002)*	
None	7.63 (3.25)	+1.81 (vs Insufficient)		No
Insufficient	5.82 (1.77)	+0.39 (vs Sufficient)		No
Sufficient	5.43 (1.56)	-2.2 (vs None)		Yes
Planned Activity			3.90 *(0.024)*	
None	7.04 (2.97)	+1.40 (vs Insufficient)		No
Insufficient	5.64 (1.40)	+0.33 (vs Sufficient)		No
Sufficient	5.31 (1.70)	-1.73 (vs None)		No
Sitting (Continuous Data)		*Standardised Beta*		
Total Sitting (hrs/wk)		+0.10 points/hr	0.77 *(0.38)*	No
Planned Sitting (hrs/wk)		+0.23 points/hr	4.42 *(0.04)*	No

Potential Covariates

As noted in Section 3.8.4, potential covariates for the final regression analyses were identified using criteria of adequate literature evidence, participant numbers > 2 in variable categories; and a statistical significance of $p \leq 0.2$ in a bivariate analysis with the independent variable. The statistical tests used for bivariate analyses were Pearson's correlation or Spearman's Rho for continuous variables, and t-tests for categorical variables. Table 4.4 lists potential covariates that met the final analysis selection criteria, in order of their bivariate analysis significance values.

Table 4.4

Significance values resulting from bivariate comparison of potential covariates and independent variable (Depressive Symptom Scores)

Potential Covariate	P Value
Anxiety Symptoms Score (HADS-A)	<0.001
Maternity Social Support Scores	0.002 [d]
Number of Pregnancy Terminations	0.008 [d]
Number of Existing Children	0.06 [d]
Whether Pregnancy was Planned	0.06 [e]
Participant Ever Diagnosed with Depression	0.07 [e]
Change in Physical Activity Level Since Pregnancy	0.08
Partner Status [a]	0.09 [e]
Current smoker	0.10 [e]
Gross Household Income [b]	0.11 [e]
Education Status [c]	0.13
Someone at home put down/humiliated participant in the last year	0.13 [e]
Gross Individual Income [b]	0.14 [e]
Problems Falling Pregnant	0.15
Alcohol intake on a 'drinking' day prior to pregnancy	0.17

[a] Dichotomous: 'Partnered' AND 'Not-partnered'
[b] Dichotomous: '< $26000 per annum' AND '≥$26000 per annum'
[c] Dichotomous: 'Secondary School Level or Lower' AND 'Post Secondary School Level'
[d] Spearman's Rho
[e] Equal Variances Not Assumed

Ordering Variables for Entry into Regression Models

The results of the bivariate analyses were used to inform the hierarchy of the variables to be entered into linear regression models. To ensure potential covariates were controlled for prior to assessing the relationships between the independent variables and dependent variable, potential covariate blocks were entered first in all regression models. Within each block, potential covariates were ordered according to the significance value of their bivariate comparison with the dependent variable, beginning with the lowest p-value. Blocks were ordered approximately by the p-value of their most significant variable; apart from demographic characteristics which by convention were in block one. Independent variable blocks were entered last in each model.

Table 4.5 illustrates the order in which all variables were entered into each regression model.

Table 4.5

Variable and block entry order for all regression models

Model No. & Name	Block No. & Description	Covariates and Independent Variables
1 Total Activity	1: Covariates *Demographic Characteristics*	Partner Status Household Income Education Status Gross Individual Income
	2: Covariates *Pregnancy & Childbirth*	Number of pregnancy terminations Number of existing children Whether pregnancy was planned Whether participant had problems falling pregnant
	3: Covariates *Social Environment*	Maternity Social Support Scores Someone at home put down/humiliated participant in the last yr
	4: Covariates *Health & Lifestyle*	Anxiety Symptoms Score (HADS-A) Change in Physical Activity Level Since Pregnancy Participant has ever been diagnosed with depression Current Smoker Alcohol intake on a 'drinking' day prior to pregnancy
	5: Independent Variable *Total Activity*	Sufficient (Yes/No) Insufficient (Yes/No)
2 Planned Activity	1-4: Covariates	As per Model 1
	5: Independent Variable *Planned Activity*	Sufficient (Yes/No) Insufficient (Yes/No)
3 Total Sitting	1-4: Covariates	As per Model 1
	5. Independent Variable *Total Sitting*	Total Time Spent Sitting (hours/wk)
4 Planned Sitting	1-4: Covariates	As per Model 1
	5. Independent Variable *Planned Sitting*	Planned Time Spent Sitting (hours/wk)
5 Total Activity & Total Sitting	1-4: Covariates	As per Model 1
	5. Independent Variable *Total Activity*	Sufficient (Yes/No) Insufficient (Yes/No)
	6. Independent Variable *Total Sitting*	Total Time Spent Sitting (hours/wk)
6 Planned Activity & Planned Sitting	1-4: Covariates	As per Model 1
	5. Independent Variable *Planned Activity*	Sufficient Planned Activity (Yes/No) Insufficient Planned Activity (Yes/No)
	6. Independent Variable *Planned Sitting*	Planned Time Spent Sitting (hours/wk)

4.3.2 HIERARCHICAL MULTIVARIABLE LINEAR REGRESSION

Six regression models that included all the variables listed in Table 4.4 were conducted. Log transformations of sitting data were not required as residuals were normally distributed.

To ensure that the physical activity and sitting variables were measuring different constructs, a variable relating to each construct was entered simultaneously into each of the final two regressions (see regressions 5 and 6 in Table 4.4). The predetermined criteria for minimally important differences in HADS depression (HADS-D) scores was half a standard deviation of the sample mean or two HADS-D points, whichever was greater (see Section 3.7.1). As half a standard deviation of the sample mean was only 1.28 (see Table 4.2), the criteria of two HADS-D points was applied to all regression results.

Summary of Results

All models were significant ($p < 0.001$) and two models indicated a statistically significant relationship between an independent variable and depressive symptoms. Collinearity was within tolerance (VIF < 2) for all variables. See Table 4.6.

Regression one produced the most significant model with the greatest parsimony. The results of this regression indicated a significant association between sufficient total activity (Yes/No) and depressive symptoms (*Unstandardised Beta = -0.9, SE Beta = 0.55, p = 0.05*). The explained variance of this model was 30.3%. The negative unstandardised beta coefficient for sufficient total activity in this model (*b = -1.09*) indicates that sufficient activity in the combined planned and transport domains is associated with a score that is 1.09 points lower on the HADS depression scale than the 'none' category; however, this result does not reach the predetermined criteria (> 2 HADS-D points) for minimally important difference.

The planned sitting time model (31.3% of variance explained) showed a trend toward significance for planned sitting time (*Unstandardised Beta = 0.04, SE Beta = 0.02, p = 0.06*) with the unstandardised beta indicating an increase of 0.04 of a point in HADS depressive symptom scores associated with each additional hour of planned sitting. This result was not clinically meaningful.

4.3.3 ADDITIONAL ANALYSES

Interaction

Evaluation of joint effect of total physical activity and total sitting data indicated no significant interaction. Although the regression model remained significant after the inclusion of the interaction variables ($F = 5.14$, $p < 0.001$) the interaction variables made no significant contribution to the model ($F = 0.943$, $p = 0.40$). Similarly, evaluation of the joint effect of planned physical activity and planned sitting data also indicated no significant interaction effect. Although the regression model was significant ($F = 4.73$, $p = 0.001$), the interaction variables made no significant contribution to the model ($F = 0.12$, $p = 0.89$).

Nesting

An additional two analyses were conducted to determine which of the models from the six original regressions were the most parsimonious. Total activity had shown a significant contribution to explained variance when it was the only independent variable of interest (in regression model 1) and also when it was included with total sitting (in regression model 5). Therefore, the first nesting analysis tested whether the explained variance of regression model 5 was diminished by removing the total sitting variable. The results indicated that the removal of total sitting decreased explained variance by 0.7%, which was not significant ($F = 1.54$, $p = 0.29$). This establishes that the regression model that included total activity but not total sitting (i.e., model 1 from the original set of 6 regressions) had the greater parsimony of the two models.

The second nesting analysis evaluated the relative contributions of planned sitting, which had shown a trend toward statistical significance in regression model 4, and planned activity, which had been included with planned sitting in regression model 6. The analysis tested whether the explanatory power of model 6 was diminished by removing the planned activity variable. The results indicated that the removal of planned activity decreased explained variance by 0.4%, which was not significant ($F = 1.18$, $p = 0.32$). This establishes that the regression model that

included planned sitting but not planned activity (i.e., model 4 from the original set of 6 regressions) had the greater parsimony of the two models.

All regression results are documented in Table 4.6, and discussed in detail in Chapter 5.

Table 4.6

Results of hierarchical regression analyses including all independent variables and significant covariates (n = 81)

Model Names & Variables	*Beta*	SE *Beta*	Std *beta*	Cumulative Adjusted R^2	*p*	Clinically Meaningful
1:Total Activity					***< 0.001***	
Covariates						
No. Existing Children	0.48	0.21	0.25	0.281	***0.02***	No
HADS-A Anxiety Score	0.21	0.08	0.30		***0.01***	No
Independent Variable						
Sufficient Total Activity	-1.09	0.55	N/A	0.303	***0.05***	No
Insufficient Total Activity	-0.62	0.53	N/A		*0.25*	No
2: Planned Activity					***< 0.001***	
Covariates						
No. Existing Children	0.50	0.21	0.27	0.281	***0.02***	No
HADS-A Anxiety Score	0.23	0.08	0.32		***0.01***	No
Independent Variable						
Sufficient Planned Activity	-0.99	0.62	N/A	0.288	*0.12*	No
Insufficient Planned Activity	-0.16	0.53	N/A		*0.76*	No
3: Total Sitting					***< 0.001***	
Covariates						
No. Existing Children	0.53	0.21	0.28	0.281	***0.01***	No
HADS-A Anxiety Score	0.25	0.08	0.35		***0.002***	No
Independent Variable						
Total Sitting	0.01	0.01	0.10	0.279	*0.37*	No
4: Planned Sitting					***< 0.001***	
Covariates						
No. Existing Children	0.50	0.20	0.26	0.281	***0.02***	No
HADS-A Anxiety Score	0.25	0.08	0.34		***0.003***	No
Independent Variable						
Planned Sitting	0.04	0.02	0.21	0.313	*0.06*	No
5: Total Activity & Total Sitting					***< 0.001***	
Covariates						
No. Existing Children	0.47	0.20	0.25	0.281	***0.02***	No
HADS-A Anxiety Score	0.21	0.08	0.29		***0.01***	No
Independent Variables						
Sufficient Total Activity	-1.20	0.56	N/A	0.303	***0.04***	No
Insufficient Total Activity	-0.47	0.54	N/A		*0.39*	No
Total Sitting	0.02	0.01	0.14	0.310	*0.22*	No
6: Planned Activity & Planned Sitting					***< 0.001***	
Covariates						
No. Existing Children	0.48	0.20	0.25	0.281	***0.02***	No
HADS-A Anxiety Score	0.23	0.08	0.32		***0.01***	No
Independent Variables						
Sufficient Planned Activity	-0.91	0.61	N/A	0.288	*0.14*	No
Insufficient Planned Activity	-0.08	0.52	N/A		*0.88*	No
Planned Sitting	0.04	0.02	0.20	0.317	*0.07****	No

** Trend towards significance as defined in Section 3.8*
P values in bold are statistically significant

Chapter 5: Discussion

5.1 INTRODUCTION

Depression during pregnancy has a prevalence that ranges between 7% and 13% (Bennett, Einarson, Taddio, Koren & Einarson, 2004) and is believed to be associated with many negative outcomes for both mother and child (Evans, Heron, Francomb, Oke & Golding, 2001), making it a significant public health issue. Within the general population, the relationship between physical activity and positive mental is well documented (Saxena, Van Ommeren, Tang & Armstrong, 2005). Findings from cross-sectional studies have indicated an inverse relationship between physical activity and depression (Goodwin, 2003), and a lack of physical activity has been established as a risk factor for poor mental health, in particular depressive symptoms (Teychenne, Ball & Salmon, 2008). Controlled clinical trials have also demonstrated that physical activity is an effective treatment for depression (Dunn, Trivedi & O'Neal, 2001). The possibility that physical activity may have a similar relationship with depressive symptoms amongst pregnant women has received limited investigation although findings from the little research that has been completed in North American women suggest an inverse relationship may exist (Koniak-Griffin, 1994; Da Costa, Rippen, Drista & Ring, 2003; Downs & DiNallo, 2008; Bowen, Stewart, Baetz & Muhajarine, 2009).

The introduction of sitting behaviour in recent literature as a measurable and important independent predictor of health issues such as diabetes (Owen, Healy, Matthews & Dunstan, 2010) may also be relevant to depression. Researchers have identified that excessive sitting behaviour is different to simply being at the very low end of the physical activity continuum (Hamer, Stamatakis & Mishra, 2010). Further, current research indicates that excessive sitting may be independently related to depressive symptoms, although this has only been explored in the general population or amongst children and adolescents (Ussher, Owen, Cook & Whincup, 2007; Hamer, Stamatakis & Mishra, 2009; Hamer, Stamatakis & Mishra, 2010).

Considering the shortcomings that have been identified for current management strategies of depression during pregnancy (Austin, 2003; Dennis, Ross & Grigoriadis, 2007; Yonkers et al., 2009), it seems prudent to explore alternatives

that may be cheaper, safer and more acceptable. In particular, health and lifestyle behaviours that are amenable to change may be particularly attractive options, if they can be shown to be effective (Dennis, Ross & Grigoriadis, 2007).

This is the first known study to investigate the potential relationship between physical activity and depressive symptoms during pregnancy in an Australian population, and no other study in Australia or elsewhere has investigated the potential relationship between sitting behaviour and depressive symptoms during pregnancy.

This chapter will discuss the study results in terms of the two questions established as research aims in Section 2.8:

1. Is there a relationship between physical activity and depressive symptoms during pregnancy?
2. Is there a relationship between the amount of time spent sitting and depressive symptoms during pregnancy?

5.2 IS THERE A RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND DEPRESSIVE SYMPTOMS DURING PREGNANCY?

Data from 81 pregnant women included in the present study indicated that those who reported sufficient physical activity also reported fewer depressive symptoms. This finding was observed whether total activity was the only independent variable in a regression or was entered into a model with total sitting time. Importantly however, while the inverse relationship was found to be statistically significant, it was not considered to be clinically meaningful according to the criteria established in Section 4.2 (minimum 2 point difference on the HADS depression scale). Planned physical activity by itself, which equates to leisure-time physical activity in other studies, showed no statistically significant relationship with depressive symptoms in the present study.

Although the total explained variance was only around 30% for either model that detected significance for independent variables, this result is tempered by reports that approximately 42% of depression in women is believed to be associated with

genetic factors (Goldberg, 2006) and these were not included in the models run for this study.

The other main contributors to explained variance across all regression models were the number of existing children and HADS anxiety scores (HADS-A), which is consistent with the literature (Ryan, Milis & Misri, 2005; Lancaster, Gold, Flynn, Yoo, Marcus & Davis, 2010).

Findings from this study are in broad agreement with the accumulating literature supporting an inverse relationship between physical activity and depressive symptoms in the general population (Camacho, Roberts, Lazarus, Kaplan, Cohen, 1991; Mobily, Rubenstein, Lemke, O'Hara, Wallace, 1996; Dunn, Trivedi, Kampert, Clark, Chambliss, 2005; Ströhle, 2009). Although the literature base examining the relationship in pregnant women is small, results from the present study are generally consistent with the majority of the available evidence, apart from one study which concluded physical activity and depressive symptoms throughout pregnancy were not correlated (Poudevigne & O'Connor, 2005). That study, however, had a very small sample size (n=12) and showed little variation in either physical activity or depression levels thus preventing a robust test of the relationship.

5.2.1 CLINICAL RELEVANCE

The literature relating to non-categorised differences in HADS scores is scarce, and therefore few studies can be used for comparison with the clinical relevance findings of the present study. While it may have been easier to declare some clinical meaning associated with the results of the present study by using categorised depressive symptom scores, there is sound justification for avoiding doing so. At a fundamental level, depression is a dimensional rather than categorical construct and the experience of symptoms below a cut-off threshold can have significant clinical relevance in terms of functional impairment, mortality, treatment and prognosis (Bjelland, Lie, Dahl, Mykletun, Stordal & Kraemer, 2009). This has led a number of experts and researchers to assert that depression is best described with dimensional symptom measures (Crawford, Henry, Crombie & Taylor, 2001; Andrews, Brugha, Thase, Duffy, Rucci & Slade, 2007; Bjelland et al 2009). In addition, from a research-practice standpoint the categorisation of continuous data commonly results

in lost information, reduced power of statistical tests and increased probability of Type II error (false negatives; Streiner, 2002).

Whilst the scarcity of data for external comparison needs to be acknowledged, the lack of clinically meaningful results in terms of the internally imposed criteria of this study must still be addressed. There is more than one possible explanation for why a depression score difference of 1.09 points associated with sufficient total activity did not meet the criteria for minimally important difference. The most obvious is that the difference is negligible and despite statistical significance, does not have much clinical meaning or importance to the individual experiencing the symptoms. However the a priori decision to use two points or half a standard deviation criterion to define clinically meaningful difference was arbitrarily imposed by statistical decision making. It may be, therefore, that a reported difference of 1.09 points on the HADS is in fact clinically meaningful in this population; and that the criterion is not a true reflection of minimally important difference in this population.

Only one study that has attempted to identify a minimally important difference in HADS depression scores was found in the literature (Puhan, Frey, Buchi & Schunemann, 2008). This study indicated that 1.5 points was a sound criterion for both the depression and anxiety scales, yet this was in patients with chronic obstructive pulmonary disease (COPD). It is not known whether the perceptions of a COPD population could be generalised to pregnant populations. Considering that even mild depressive symptoms cannot be considered benign and may well progress to major depressive illness (Weissman, Neria, Gameroff & Pilowsky, 2010) and that moderate-to-major depression during pregnancy or postpartum is associated with deleterious outcomes for both mother and infant (Pearlstein, 2008), it is not inconceivable that the differences observed in this study are important within pregnant populations.

Further, since differences in depressive symptom scores were not particularly large for any of the significant covariates in the regression modelling process, the differences associated with sufficient total activity may be clinically meaningful relative to other established risk factors. For example, the covariate 'HADS anxiety scores' was by far the most statistically significant variable in every model *(p between 0.002 and 0.011)*, yet despite statistical significance and strong literature evidence of association (Lancaster, 2010), this variable never showed a beta value

higher than 0.25 in any of the models. This means that for each single point increase in HADS anxiety scores there was an associated increase of a quarter of a point in HADS depression scores, or conversely, HADS anxiety scores needed to increase by four points (19% on a 21 point scale) before an associated single point difference in HADS depression scores was observed. Although beta values for continuous data (e.g. HADS anxiety scores) cannot be directly compared with the beta for the categorical sufficient total activity variable; it is possible that the observed associations between depressive symptoms scores and sufficient total activity were at least as clinically meaningful as those observed for any other variable in the regression modelling process.

5.2.2 PHYSICAL ACTIVITY CONTEXT

The statistically significant difference in mean depressive symptom scores between participants who reported no moderate-to-vigorous activity in a typical week and those who reported meeting current physical activity guidelines, was observed only when transport-related physical activity was combined with planned activity (total activity). This seems to contradict comparable studies that have observed an inverse relationship between leisure-time physical activity and depressive symptoms in pregnant populations (Da Costa, Rippen, Drista and Ring, 2003; Downs & DiNallo, 2008; Bowen, Stewart, Baetz and Muhajarine, 2009). However, upon closer examination it is apparent that these studies have not specifically excluded transport-related physical activity from their results. For example, the Leisure-Time Physical Activity Questionnaire used by Downs and DiNallo (2008) measures exercise in an individual's 'free time', but does not specifically exclude transport-related activity that could be undertaken during 'free time' (e.g. walking children to school). Similarly, other studies reporting positive results in pregnant populations have either not stated the context in which physical activity was measured or only excluded contexts other than transport (e.g. occupational; Da Costa et al., 2003; Bowen et al., 2009).

The variation in methods of data collection, classification and reporting between existing studies and the current study makes a detailed comparison of results somewhat difficult. Observational studies exploring the relationship between physical activity and depressive symptoms in the general population have similar

issues relating to inconsistent reporting of the frequency, duration (or total time) and context associated with lower levels of depressive symptoms (Teychenne et al, 2008). However, the contribution of transport-related physical activity to the observed differences in mean depressive symptom scores in this study appears to be a novel finding for this population, although it is consistent with the acceptance of transport as a context in which health enhancing physical activity can take place (Armstrong, Bauman & Davies, 2000).

5.3 IS THERE A RELATIONSHIP BETWEEN SITTING TIME DURING PREGNANCY AND DEPRESSIVE SYMPTOMS?

Overall, depression scores did not differ significantly according to the amount of time participants reported sitting, and differences in depression scores according to sitting time did not satisfy the criterion for clinical relevance. This was true for models in which *total* sitting time (all domains) or *planned* (leisure-time) sitting were the only independent variables and also for models where physical activity variables were also included.

There was, however, a trend towards significance identified between planned sitting time and depressive symptoms scores. The standardised beta value indicated that each standard deviation increase in planned sitting time was associated with around a fifth (21%) of a standard deviation increase in HADS depressive symptoms. The unstandardised beta in this model indicates that each additional hour of planned sitting was associated with a 0.04 point increase in HADS depressive symptom scores. This means that while a one hour increase in planned sitting time was not associated with an increase in HADS scores of two points or more (i.e., criterion for clinically meaningful result), a 50 hour increase in planned sitting time *was* associated with a two point increase in HADS depressive symptom scores, which meets the criterion for a clinically meaningful result. While 50 hours seems to be an extensive amount of planned sitting, the sample range for planned sitting was 56 hours.

Recent research indicates that screen-based leisure-time activities (i.e., television, video and computer gaming), are associated with poorer mental health in adults (Hamer, Stamatakis & Mishra, 2010), lower psychological wellbeing in

adolescents (Ussher, Owen, Cook & Wincup, 2007) and higher levels of psychological distress in children (Hamer, Stamatakis & Mishra, 2009). In this study, planned sitting time only trended towards significance, without reaching the $p \leq 0.05$ criterion, which suggests that these findings may be contrary to other sitting-based studies. However, this apparently contradictory result may relate to how sitting is measured across different studies. This is discussed in detail below. As previously noted, the other main contributors to explained variance across all regression models were the number of existing children and HADS anxiety scores (HADS-A), consistent with the existing literature (Ryan et al, 2005; Lancaster et al, 2010).

5.3.1 SITTING TIME CONTEXTS

The investigation of sitting time as a construct associated with mental health is very new, and the present study is therefore one of the few to present findings in any population; and the only study to report findings for a pregnant population. While none of the results relating to sitting time reached statistical significance or the criterion for minimally important difference, there are a few noteworthy observations particularly in relation to context.

The trend associated with the planned sitting time model did not meet the criteria for minimally important difference although the adjusted R^2 value of this model indicated that planned sitting contributed 3.2% towards the total 31.3% of explained variance of the model. Conversely, the regression model that included total sitting time did not show any trend towards significantly higher depressive symptom scores as total sitting time increased. There were no studies found in the literature that have included *total* sitting time as an independent variable in a study investigating depressive symptoms, and the lack of trends or significant findings for total sitting time in the present study suggest that the current research focus on *planned* (leisure-time) sitting, as opposed to overall sitting time, is probably justified.

The non-significant findings relating to *planned* sitting time in the present study can be interpreted in two ways. It could be that the relationship between planned sitting time and mental health, observed in other adult, adolescent and child populations (Hamer, Stamatakis & Mishra, 2010; Ussher, Owen, Cook & Wincup, 2007; Primack, Swanier, Georgiopoulos, Land & Fine, 2009; Hamer, Stamatakis &

Mishra, 2009) simply does not exist for pregnant women. However the trends identified in this study with regard to planned sitting time suggest that such a conclusion may be incorrect. Alternatively, the potential relationship between sitting during leisure-time and depression during pregnancy may have been influenced by whatever other activities participants performed while they were sitting. For example, those participants who were sitting to watch television may have had higher depressive symptom scores than participants who were sitting to read, engage in social activities or surf the internet. If this was the case, the observed trend reflects an average of varying associations between depressive symptoms and multiple sitting-based leisure-time activities. Had 'television-sitting', which was not measured separately in this study, been isolated as an independent variable, a significant association may have been observed.

There is some support in the literature for this possibility. Studies that have demonstrated a link between sitting and depressive symptoms have used measures of the time spent watching television, video cassettes and computer games as proxies for sitting behaviour, and have found that television viewing is associated with higher levels of depressive symptoms than other sitting-based activities (Hamer et al., 2009; Primack et al., 2009; Hamer et al., 2010). Several factors, including the possibility that television advertising may create a sense of inadequacy in the viewer, have been proposed as potential mechanisms (Primack et al., 2009). However, since causality is not established, the associations between television-based sitting time and depressive symptoms that have been observed in other studies may simply indicate that high levels of depressive symptoms lead to excessive television watching.

These are hardly conclusive results indicating robust associations, yet they do suggest that planned sitting time is worthy of further investigation in relation to mental health within pregnant populations. Future researchers may be well-advised to measure different types of sitting-based leisure-time activities separately.

5.4 SITTING AND PHYSICAL ACTIVITY AS SEPARATE CONSTRUCTS

A subsidiary aspect of the present study was to check whether physical activity and sitting variables were measuring separate constructs by including both physical

activity and sitting variables in two of the regression models. The expectation was that if sitting was simply a measure of very low levels of physical activity, any identified associations between physical activity and depressive symptom scores would be weakened by the inclusion of sitting time variables and vice-versa. Factors that could indicate how well the physical activity and sitting variables measured their respective constructs include explained variance (adjusted R^2 values), differences in depressive symptom scores (beta values) and statistical significance (p values). Evaluation of these factors reveals a slight variation in findings dependent on context.

For the model with the only statistically significant independent variable (i.e., total activity), both physical activity and sitting variables appeared to measure different constructs. The inclusion of total activity and total sitting time in a model together, did not cause significant changes in their individual adjusted R^2 values, beta values or p-values. This suggests that they were not sharing explained variance with each other.

Similarly, the inclusion of planned sitting time and planned activity together in the same model did not significantly change their individual contributions to explained variance. This suggests that planned sitting and planned activity were not sharing explained variance with each other.

The implication of these findings is that the regression models were measuring independent associations between total physical and depressive symptoms, and planned sitting and depressive symptoms.

5.5 LIMITATIONS OF THE PRESENT STUDY

The most obvious limitation of this study is that it is cross-sectional and therefore does not imply causation. Nevertheless, findings still make an important contribution to the body of knowledge in this area.

This study was also limited by the fact that measurement of physical activity data was based on self-report. While self-report is generally used for data collection at population level due to factors such as cost, practicality, low participant burden and general acceptance, it is vulnerable to errors relating to over and under-

estimation (Prince, Adamo, Hamel, Hardt, Gorber & Tremblay, 2008). The AWAS has been shown to be a valid and reliable self-report instrument; nevertheless self-report data can suffer over reporting bias: AWAS is no exception (Fjeldsoe et al., 2009). The potential influence of over reporting bias in reported physical activity is difficult to ascertain. Unfortunately, despite recognising that this issue may exist, little can be done to eradicate the potential and the same issue will exist for all studies using self-report methods for physical activity. On a positive note, measurement properties of the AWAS are comparable to those of other self-report instruments (Fjeldsoe et al., 2009), and, therefore, results from the present study can be considered as sound as those from any other study using validated self-report measures.

Another potential limitation of this study is the demographic characteristics of the participants. It is known that depression during pregnancy is more prevalent in socially disadvantaged women (Bowen et al, 2009) and that lower levels of physical activity are more likely amongst populations with low socioeconomic status (Gidlow, Johnston, Crone, Ellis & James, 2006). As already noted, participants in the present study were more likely to be partnered and have higher household incomes than a Queensland-wide sample, suggesting limited representation of women with low socioeconomic status. This means that the present study may not have captured data from those women who are most likely to be both vulnerable to depression during pregnancy and engage in low levels of physical activity. Further, data relating to pregnancy complications was not captured by this study, so it is not known how many women were experiencing complications and what, if any, implications this may have had in relation to depressive symptoms scores.

Limitations relating to specificity of the independent variable data used for analyses should also be noted. In the first instance, more specific data relating to the activities in which participants were engaged during their planned sitting time may have provided greater insight into potential relationships between sitting-based leisure-time activities and depressive symptoms. Secondly, systematic exploration of the comprehensive physical activity data captured by AWAS was beyond the scope of this project. Instead, the data was reduced to a ‘dose’ defined by current physical activity guidelines. Although this enabled the comparison of groups based on whether participants reported meeting current guidelines, further research in this area

may be improved by systematically exploring the relationships between all physical activity domains and by using continuous data in analyses.

The final two limitations relate to the statistical analysis process. The first limitation was that five variables that met the bivariate significance and literature evidence criteria were excluded from the regression analyses, because their categories contained too few participants. The excluded variables were the domestic violence indicators of 'participant ever afraid of partner', 'participant hit/kicked/punched at home in last year' and 'participant threatened with harm by partner in last year'; and the health and lifestyle variables 'participant stated postnatal depression after birth of 3rd child' and 'high risk alcohol intake since pregnant'. The impact of excluding these variables is unknown. The second statistical process limitation was that the ratio of independent variable-to-participants in this study was only 5:1. The preferred ratio for multivariable regression modelling is 20:1. Although the ratio in this study met the minimum criterion, it requires results to be interpreted with caution. Reducing the number of covariates in the analyses would have improved this ratio; however, due to the large number of risk factors implicated in relation to depressive symptoms, this was not a sound option. A sample size of approximately 300 would also have addressed this issue; however, the study sample size was influenced by the fact that it was a pilot to establish the feasibility of a larger study (n = 650) and that participants were lost with each additional source of data (i.e., face-to-face survey, telephone interview and hospital records). Further related research using multivariable regression analyses will need to take account of the large number of risk factors that may require inclusion when sample size is calculated.

5.6 STRENGTHS OF THE PRESENT STUDY

This study is the first to explore the relationships between physical activity, sitting and depression amongst a sample of pregnant Australian women. The sample was broadly representative, and findings may therefore be generalisable to the broader population of pregnant women in Queensland. However, it should be noted that in comparison with Queensland census data and AIHW data (Laws & Sullivan, 2009) on women having babies in Queensland, the participants in the present study

were more likely to be partnered and have higher household incomes, both factors that may influence the risk of depression during pregnancy.

The inclusion of sitting behaviour as an independent variable in this study is novel, and considering the identified trends in a small sample, may be significant for future research in this area. While findings in relation to sitting behaviour and depressive symptoms were not identified as statistically significant, the present study also provides data about the prevalence of sitting behaviour amongst pregnant Australian women that has not been captured by other similar studies.

The depth of information available for the purposes of establishing covariates was also greater in this study than that reported by other similar studies. The use of two separate surveys and gaining access to hospital records after birth have resulted in the present study being able to perform a comprehensive data analysis that accounted for the influence of many covariates that may have been overlooked in similar studies. For example, the inclusion of anxiety as a covariate was seen only in one other study investigating physical activity and depressive symptoms amongst pregnant populations (Da Costa et al., 2003). This is despite much evidence indicating the association between anxiety and depression (Lancaster et al., 2010). Considering that anxiety was consistently the most significant covariate across all regression models in the present study, the importance of accounting for its association with depressive symptoms during pregnancy cannot be overstated.

Finally, the use of continuous data in relation to HADS depressive symptom scores is an important contribution to what is known about ‘norms’ for this scale in pregnant populations. Although this may have made comparisons with other studies more difficult, it has contributed to the quality of the analysis in the present study and may be of benefit to other researchers who wish to compare scores rather than categories.

5.7 IMPLICATIONS FOR POLICY AND PRACTICE

Within the broader research perspective, the present study provides basic data about the relationship between physical activity and depressive symptoms, and sitting and depressive symptoms, amongst a group of pregnant Australian women. Specifically, this project has contributed to the body of public health knowledge by

identifying a statistically significant association between sufficient physical activity and depression, and a positive correlation that met the criteria for a statistical trend between sitting behaviour and depression, in a pregnant Australian population. Although the association between physical activity and depression has long been documented in non-pregnant populations, it has not been explored amongst pregnant Australian women. The findings from the present study do not imply causation, although evidence from intervention studies conducted with the general population indicates that physical activity is effective as a treatment and possibly as a preventive measure for depression (Dunn, Trivedi, Kampert, Clark & Chambliss, 2005; Collins & Dozois, 2008; Conn, 2010). Nevertheless, this study does provide further confirmation of the relationship between physical activity and depressive symptoms amongst pregnant Australian women, and despite the lack of evidence regarding causation; results suggest that meeting physical activity guidelines during pregnancy is associated with better maternal health outcomes. In addition, the results from the present study provide base-level data about a potential relationship between sitting and depressive symptoms amongst pregnant Australian women, which may help to inform further research into behavioural interventions within this population.

Current Australian policies and practices addressing depression during pregnancy are not yet standardised; however, the *beyondblue* draft clinical guidelines include two areas of focus that are relevant to this study. The first is the recommendation that clinicians should provide psychosocial support that includes physical activity advice for pregnant women who are at risk of, or experiencing, a mental health disorder (*beyondblue*, 2010). This recommendation is supported by the findings of this study and is especially pertinent considering that physical activity levels often decline during pregnancy (Poudevigne & O'Connor, 2006). It may be beneficial if such a recommendation becomes standard clinical practice, particularly in circumstances where clinicians hold negative attitudes towards physical activity during pregnancy. For example, it has been estimated that obstetricians and gynaecologists in the United States recommend complete inactivity (bed-rest) in around 20% of all pregnancies (Poudevigne & O'Connor, 2006), in the hope of avoiding spontaneous abortion, preterm labour, foetal growth retardation, oedema and pre-eclampsia. This is despite the fact that there is little evidence to suggest that such measures are effective. While the results from the present study cannot be used

as conclusive evidence to change the practices of clinicians in the United States or Australia, they do contribute to an evidence base which is drawn upon by current Australian draft guidelines and they also suggest that wherever there is no evidence indicating that it is likely to have a deleterious impact on mother or infant, it is better to promote physical activity and avoid recommending total inactivity.

The second area of interest in the draft clinical guidelines relates to a recommendation of screening to identify psychosocial risk factors and depressive symptoms as part of routine antenatal care (*beyondblue,* 2010). An in-depth analysis of the arguments for and against screening was not part of the scope of this study. However, considering that the prevalence of depression during pregnancy is estimated to be as high as 13% (See Section 2.4) and that it has been linked to depression in the postnatal period (Leigh & Milgrom, 2008), screening does make intuitive sense. Nevertheless, it has received varying degrees of support amongst the research community (Austin, 2004).

The evidence indicating maternal and infant health benefits as a result of physical activity or exercise during pregnancy remains inconclusive (Kramer and McDonald, 2006), but what can be confidently concluded is that physical activity (including exercise) can improve maternal fitness (Kramer and McDonald, 2006) and is not contra-indicated in a normal low-risk pregnancy (Drake, 2003). Further, there is mounting evidence that depression during pregnancy is associated with negative health outcomes for mother and child (Pearlstein, 2008) and that there is an association between physical activity during pregnancy and better maternal mental health (Poudevigne & O'Connor, 2006). When these points are considered in tandem with evidence from the general population indicating that physical activity is protective against depression (Teychenne et al, 2008), there is a sound basis for reviewing the current policies and practices relating to physical activity during pregnancy. Findings from the present study may help to inform further development of policies promoting physical activity during pregnancy in addition to providing preliminary support to further investigate the role of excessive sitting during pregnancy and depressive symptoms during pregnancy.

5.8 RECOMMENDATIONS

At present, there is insufficient evidence to point to lack of physical activity or high levels of sitting behaviour as causal agents of depression during pregnancy. As indicated by the literature review (See Chapter 2), the focus of the present study has received little investigation thus far. Considering the potential negative outcomes of depression during pregnancy and the shortcomings of current management practices, more work needs to be done in this area.

A sound evidence base is required to clarify the relationships between physical activity, sitting and depressive symptoms during pregnancy and to translate research into policy and practice. It is important, therefore, that further research includes large representative samples, preferably longitudinal by design, followed by the development and evaluation of preventative and treatment interventions. Large studies are required to establish the optimal frequency, intensity and duration of physical activity necessary to decrease depressive symptoms during pregnancy. Longitudinal studies can help to determine directionality of the relationship, and small interventions contribute to an understanding of directionality, dose-response and effectiveness. Without such evidence policy makers can remain justifiably reluctant to develop or support radical changes in maternal health service recommendations. This is regardless of the fact that these strategies may be cheaper, safer and more acceptable to pregnant women than psychosocial and pharmacological therapies.

It is also necessary to focus on groups that may be particularly vulnerable. For example, women who are un-partnered, have a high number of existing children, are pregnant at a young age or have experienced previous episodes of depression are important to include as research participants, as these groups potentially have the most to gain from screening and effective low cost evidence-based interventions. The inclusion of high-risk individuals can provide particular insight into specific circumstances that may contribute to their risk and also contribute to the evidence base in relation to how to encourage uptake and adherence for physical activity in vulnerable populations.

Finally, it is important to note that depression during pregnancy is a relatively common occurrence with serious consequences. Therefore, it is entirely sensible to thoroughly investigate the effectiveness of physical activity as a potential

management option that may offer additional health benefits and does not have the accessibility issues, cost and possible risks of current options such as psycho-social counselling and medication.

5.9 CONCLUSION

With the greater focus on depression as a chronic health issue with a high morbidity and mortality burden, it is becoming apparent that low cost, low risk, accessible and effective management options will become increasingly important. This is particularly true for depression during pregnancy, where a large proportion of the costs impact a fundamental unit of society, the family.

As the prevalence of depression in the general population continues to increase, there is no reason to expect that this increase will not also be reflected in pregnant populations. Although the progress of research in this particular population is nowhere near the point of that in the general population, the evidence implicating physical inactivity and excessive sitting as risk factors for depression during pregnancy is continuing to grow. Further, pregnancy is a time where the health care system has unprecedented opportunity to implement behaviourally-focused interventions due to access to the population of interest and the inclination of women to be more interested in managing their wellbeing during this time. It is therefore important that the focus on depression is maintained and that it is broadened to include a specific focus on pregnant populations. It is also important that physical activity, a behaviour already known to be beneficial, is explored to establish what contribution it may be able to make for the management of depression during pregnancy.

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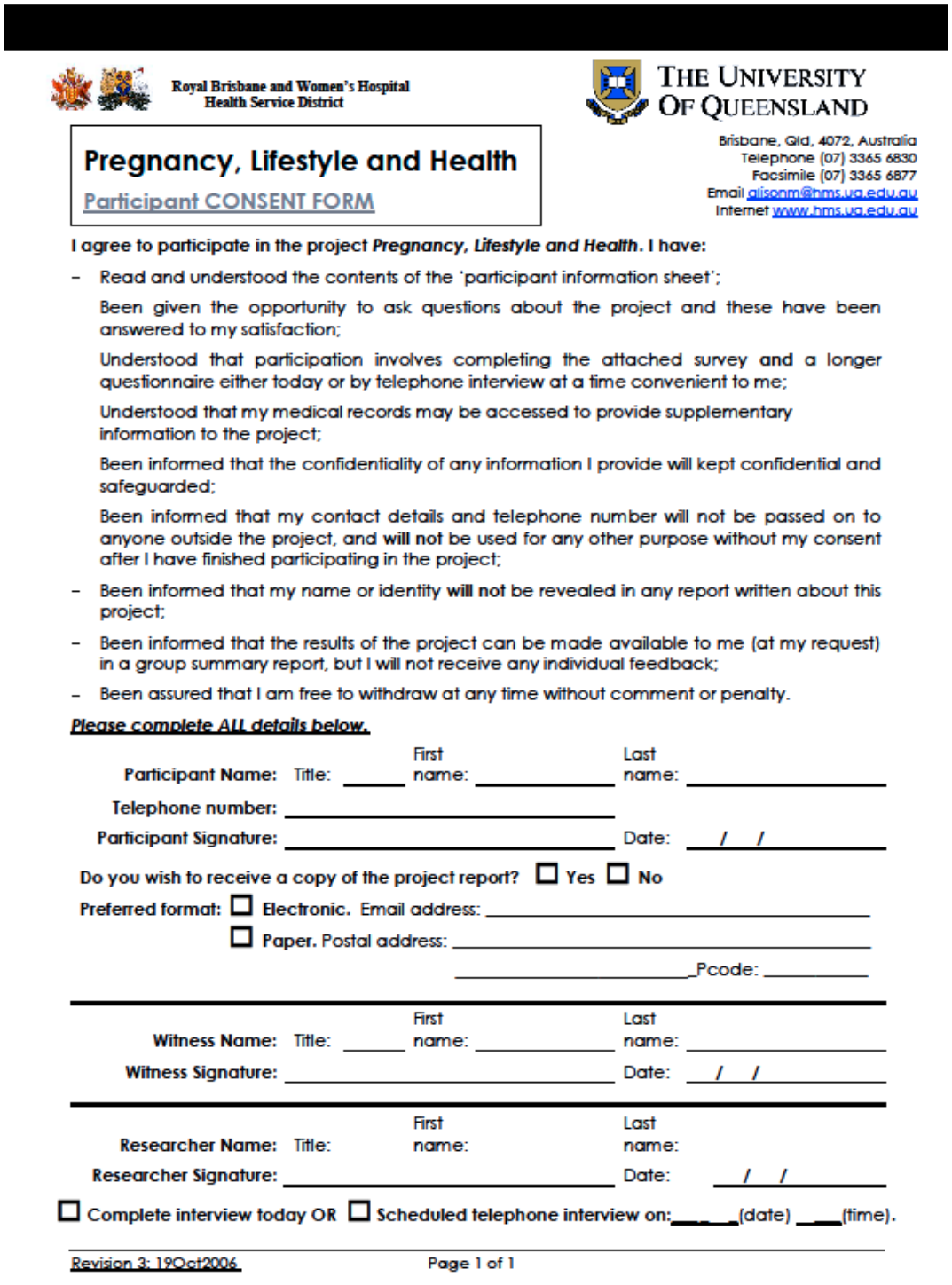
Appendices

APPENDIX A: PARTICIPANT INFORMATION AND CONSENT FORM



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Pregnancy, Lifestyle and Health

Participant CONSENT FORM

I agree to participate in the project *Pregnancy, Lifestyle and Health*. I have:

- Read and understood the contents of the 'participant information sheet';

  Been given the opportunity to ask questions about the project and these have been answered to my satisfaction;

  Understood that participation involves completing the attached survey **and** a longer questionnaire either today or by telephone interview at a time convenient to me;

  Understood that my medical records may be accessed to provide supplementary information to the project;

  Been informed that the confidentiality of any information I provide will kept confidential and safeguarded;

  Been informed that my contact details and telephone number will not be passed on to anyone outside the project, and **will not** be used for any other purpose without my consent after I have finished participating in the project;
- Been informed that my name or identity **will not** be revealed in any report written about this project;
- Been informed that the results of the project can be made available to me (at my request) in a group summary report, but I will not receive any individual feedback;
- Been assured that I am free to withdraw at any time without comment or penalty.

Please complete ALL details below.

Participant Name: Title: _____ First name: _____ Last name: _____

Telephone number: _____

Participant Signature: _____ Date: __/__/____

Do you wish to receive a copy of the project report? ☐ **Yes** ☐ **No**

Preferred format: ☐ **Electronic.** Email address: _____

☐ **Paper.** Postal address: _____

_____ Pcode: _____

Witness Name: Title: _____ First name: _____ Last name: _____

Witness Signature: _____ Date: __/__/____

Researcher Name: Title: First name: Last name:

Researcher Signature: _____ Date: __/__/____

☐ **Complete interview today OR** ☐ **Scheduled telephone interview on:** ____(date) ____(time).

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APPENDIX B: SHORT SURVEY

Date: _____ URN: _____

Pregnancy, Lifestyle and Health Questionnaire

Royal Brisbane and Women's Hosp
Health Service District
THE UNIVERSITY OF QUEENSLAND

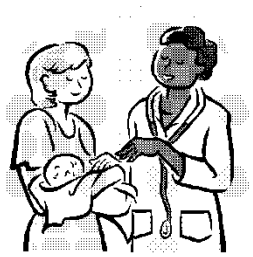
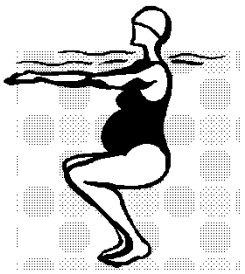
We are interested in the lifestyle and health of women who are pregnant.

The findings will be used to develop programs to improve the health of women and their families.

There are no wrong or right answers to these questions.

If you are unsure about how to answer a question, please give the best answer you can.

ALL responses are confidential.

Please complete **this short** questionnaire today.

We would also like to telephone you to ask a few more questions sometime within the next week. You can discuss the most appropriate time with the research assistant who gave you this questionnaire.

Please answer every question as accurately as you can.
If you are unsure of an answer to any question, please try and provide the best response you can

ALL Information Given Here Will Be Kept Confidential

1 What is your date of birth? *(Please PRINT clearly in the boxes)*

Day ☐☐ - Month ☐☐ - 19 Year ☐☐

2 What is your RESIDENTIAL postcode? *(Please PRINT clearly in the boxes)* ☐☐☐☐

3 What is your weight? *(Please PRINT clearly in the boxes below)*

☐☐ kg **OR** ☐☐ stone ☐☐ pounds

4 What is your height? *(Please PRINT clearly in the boxes below)*

☐☐☐ cm **OR** ☐☐ feet ☐☐ inches

5 What is your present marital status? *tick one box*

Never married	Married	De facto	Separated	Divorced	Widowed
☐	☐	☐	☐	☐	☐

6 Are you: ***tick one box***

Aboriginal but not Torres Strait Islander	Torres Strait Islander but not Aboriginal	Both Aboriginal and Torres Strait Islander	Other	None of the these	Refused
☐	☐	☐	☐	☐	☐

7 What language do you usually speak at home?
(Please write on space provided) _____

8 What is the HIGHEST qualification you have completed? *(Please tick one only)*

No formal qualification ☐
Year 10 or Year 12 equivalent (eg. School Certificate, Higher School Certificate) ☐
Trade/apprenticeship (eg. Hairdresser, chef) or Certificate/diploma (eg.child care, technician) ☐
University Degree or Higher ☐

9 When is your expected due date? *(Please write date on space provided)* _____

11 How active would you say you are NOW compared to before you became pregnant with this child? *tick one box*

Much more active	More active	About the same	Less active	Much less active
☐	☐	☐	☐	☐

12 How much physical activity do you think you should be doing whilst you are pregnant?

_____

_____

_____

13 Please tick the box next to the statement which comes closest to how you have felt in the <u>past 7 days</u>. Not just how you feel today.

I have been able to laugh and see the funny side of things	As much as I always could ☐ Not quite so much now ☐ Definitely not so much now ☐ Not at all ☐
I have looked forward with enjoyment to things	As much as I ever did ☐ Rather less than I used to ☐ Definitely less than I used to ☐ Hardly at all ☐
I have blamed myself unnecessarily when things went wrong	Yes, most of the time ☐ Yes, some of the time ☐ Not very often ☐ No, never ☐
I have been anxious or worried for no good reason	No, not at all ☐ Hardly ever ☐ Yes, sometimes ☐ Yes, very often ☐
I have felt scared or panicky for no good reason	Yes, quite a lot ☐ Yes, sometimes ☐ No, not much ☐ No, not at all ☐
Things have been getting on top of me	Yes, most of the time I haven't been able to cope at all ☐ Yes, sometimes I haven't been coping as well as usual ☐ No, most of the time I have coped quite well ☐ No, I have been coping as well as ever ☐
I have been so unhappy that I have had difficulty sleeping	Yes, most of the time ☐ Yes, sometimes ☐ Not very often ☐ No, not at all ☐
I have felt sad or miserable	Yes, most of the time ☐ Yes, quite often ☐ Not very often ☐ No, not at all ☐
I have been so unhappy that I have been crying	Yes, most of the time ☐ Yes, quite often ☐ Only occasionally ☐ No, never ☐
The thought of harming myself has occurred to me	Yes, quite often ☐ Sometimes ☐ Hardly ever ☐ Never ☐

Please stop here
<u>Return</u> to the interviewer so that they can complete the next section with you.

PART 2
Australian Women's Activity survey

**** INTERVIEWER ADMINSTERED ****
Use interviewer instruction sheet

This question aims to assess the amount of activity you do.

Category A **PLANNED ACTIVITIES**

		Monday-Friday			Saturday-Sunday		
Sitting: eg. watching TV, reading etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Light effort: eg. slow walking, stretching, fishing, playing in water, golf with a cart etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Brisk walking: eg. walking for exercise, walking the dog etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Moderate Effort (not including walking): eg. social sports, tai chi, doubles tennis, slow cycling, low-impact aerobics, ballroom dancing, golf without a cart etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Vigorous Effort: eg. running, jogging, swimming laps, singles tennis, competitive sports, rowing, high-impact aerobics etc	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day

Category B **WORK**

Do you work, study or volunteer for an organisation? *(tick one box only)*

☐ yes → Please complete this question (B1)

☐ no → Skip to Question B2 about Childcare

B1. Employment

		Monday-Friday			Saturday-Sunday		
Sitting: eg. desk work like sitting at a computer etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Light effort: eg. mostly standing at counter, standing at photocopier etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Moderate Effort: eg. mostly brisk walking like teaching, nursing, waiting on tables etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Vigorous Effort: eg. manual labour (digging ditches, laying bricks), loading trucks, moving furniture etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day

Do you look after children (your own, your partner's or fostered)? *(tick one box only)*

☐ yes → Please complete this question (B2)

☐ no → Skip to Category C about Domestic Responsibilities

B2. Childcare

		Monday-Friday			Saturday-Sunday		
Sitting: eg. breast feeding, reading to children etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Light Effort: eg. bathing, feeding, playing with child inside, picking up toys etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Moderate Effort: eg. lifting or carrying child, pushing pram, playing with child outside etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Vigorous Effort: eg. carrying child upstairs, carrying child whilst shopping, playing strenuous games with child outside etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day

Category C **DOMESTIC RESPONSIBILITIES**

		Monday-Friday			Saturday-Sunday		
Sitting: eg. sewing, mending, knitting etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Light Effort: eg. preparing meals, laundry, washing dishes, grocery shopping, watering plants etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Moderate Effort: eg. vacuuming, mopping, raking, cleaning windows, cleaning the bath, washing car, cleaning gutters, digging in garden, painting walls etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Vigorous Effort: eg. moving furniture, carrying groceries upstairs, pushing the lawn mower etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day

Category D **TRANSPORT**

		Monday-Friday			Saturday-Sunday		
Sitting: eg. driving a car, sitting on a bus or train etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Light Effort: eg. walking slowly etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Brisk walking: eg. walking to get places, walking to the bus etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Moderate Effort (not including walking): eg. riding a bike, riding a push scooter etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day
Vigorous Effort: eg. running/ jogging to get somewhere etc.	☐ yes → ☐ no	# days	hrs/day	mins/day	# days	hrs/day	mins/day

Thank you for your participation.

APPENDIX C: TELEPHONE INTERVIEW

Hello, I'm _____ from the School of Human Movement Studies at the University of Queensland. May I speak with _____?

[If the person who answers the phone is not the respondent and is reluctant to pass you to the correct person, say]

Our representative met _____ at the Royal Brisbane and Women's Hospital in the last week and she has arranged today at this time to have a telephone interview with us.

[If participant is not available, arrange a time to call back]

Enter call-back:_____Date_____Time

[If participant is unwilling to participate themselves say]

The research we are conducting is important for improving health care among pregnant women. Your participation is important and can really help us improve health care in Queensland.

- O Yes
- O No-refused
- O call-back:_____Date_____Time

[Once speaking with the participant, repeat explanation and say]

Our representative met you at the Royal Brisbane and Women's Hospital and you agreed to a telephone interview today. This survey will take about 20 minutes and the call may be monitored for quality and training purposes (assure participant that it will not, however be recorded). It is important that you answer all questions as accurately as you can.

[If necessary say] The answers that you give are combined with those of hundreds of others. All data given here will be stored in password protected files and will only be accessible to the relevant researchers. Your personal information and contact details will NOT be passed on to anyone outside the project.

Are you ready to start?

Section A

Introduce this section by saying:
This first section includes some general questions about you.

1. What is your date of birth?

		-			- **19**		

Day **Month** **Year**

2. In which country were you born?

1. Australia
2. Other (please specify) _____

3. Which of the following BEST describes your MAIN current employment status? [READ LIST]

1. Home duties only - no paid work
2. In full time paid work
3. In part time or casual paid work
4. Work without pay (e.g., in a family business)
5. Studying
6. Unemployed - looking for work
7. Unpaid voluntary work
8. Unable to work due to sickness or injury
9. Other [PLEASE SPECIFY]_____

4. What is your <u>usual</u> main occupation? [DO NOT READ LIST – CATEGORISE JOB AFTER RESPONSE GIVEN BY PARTICIPANT. IF UNSURE, NOTE DOWN OCCUPATION]

1. Manager or administrator
(e.g., magistrate, farm manager, media producer, general manager, director of nursing, school principal)
2. Professional
(e.g., accountant, doctor, registered nurse, allied health professional, teacher, artist)
3. Associate professional
(e.g., technician, office manager, branch manager, shop manager, coach, retail buyer, youth worker, police officer)
4. Tradesperson or related worker
(e.g., sign writer, cook, dressmaker, hairdresser, gardener, florist)
5. Advanced clerical or service worker
(e.g., bookkeeper, credit officer, secretary, personal assistant, flight attendant, law clerk)
6. Intermediate clerical, sales, or service worker
(e.g., accounts clerk, checkout supervisor, receptionist, child care worker, nursing assistant, hospitality worker)
7. Intermediate production or transport worker
(e.g., sewing machinist, machine operator, bus driver)
8. Elementary clerical, sales or service worker
(e.g., filing/mail clerk, parking inspector, sales assistant, telemarketer, housekeeper)
9. Labourer or related worker
(eg., cleaner, factory worker, general farm hand, kitchen-hand, fast food cook)
10. No paid job
11. Unsure of job category [PLEASE RECORD STATED OCCUPATION]_____

5. Which of the following BEST describes the household you live in? Do you… [READ LIST]

1. Live with your partner/spouse only
2. Live with your partner/spouse and child or children
3. Live with just your child or children

4. Live with other adults (no children)
5. Live with your own parent/s (with or without brothers/sisters)
6. Other [PLEASE SPECIFY]_____

6. What was your weight <u>prior to your first</u> pregnancy?

		Kg	**<u>OR</u>**			**stone**			**pounds**

7. The next questions are about the average gross (before tax) income that you receive each week, including pensions, allowances and financial support from parents. You also have the options of saying you don't know or you prefer not to answer these questions.

a) What is your own individual average gross weekly income? [If participant appears unsure, offer to read the income brackets to them]

1. No income
2. $1 - $119 ($1- $6,239 annually)
3. $120 - $499 ($6,240 - $55,999 annually)
4. $500 - $999 ($26,000 - $51,999 annually)
5. $1000 or more ($52,000 or more annually)
6. Don't know
7. Don't want to answer

b) What is the average gross HOUSEHOLD income, including income from all household members including you, your partner, your parents etc. [If participant appears unsure, offer to read the income brackets to them][Record response in table below]

1. No income
2. $1 - $119 ($1- $6,239 annually)
3. $120 - $499 ($6,240 - $55,999 annually)
4. $500 - $999 ($26,000 - $51,999 annually)
5. $1000 or more ($52,000 or more annually)
6. Don't know
7. Don't want to answer
8. I live alone (household income is the same as mine)

Section B

Introduce this section by saying
The next group of questions are about your health

8. I will read a list of statements about THIS pregnancy that may be relevant to you. For each statement please tell me if it applies to you or not. [READ LIST]

I meant to avoid pregnancy at this time
0 No
1 Yes
2 Unsure

My method of contraception failed
0 No
1 Yes

2 Unsure

I <u>planned</u> to get pregnant at this time
0 No
1 Yes
2 Unsure

I <u>wanted</u> to get pregnant at this time
0 No
1 Yes
2 Unsure

Did you have any problems becoming pregnant
0 No
1 Yes
2 Unsure

9. When you <u>became</u> pregnant were you taking any prescribed medications?
0 No
1 Yes

[IF YES] **what was the medication?** [RECORD ALL MEDICATIONS]_____

_____

10. When you <u>found out you were</u> pregnant did you STOP taking any prescribed medications?
0 No
1 Yes
[IF YES] **Which medications did you stop taking?** [RECORD ALL MEDICATIONS]_____

_____

11. Have you ever been diagnosed with any of the following: [READ LIST]

Insulin dependant (Type 1) diabetes
0 No
1 Yes

Non-insulin dependant (Type II) diabetes (other than diabetes during pregnancy)
0 No
1 Yes

Gestational Diabetes (diabetes during pregnancy)
0 No
1 Yes

Depression
0 No
1 Yes

Postnatal depression
0 No

1 Yes

Anxiety
0 No
1 Yes

Hypertension or high blood pressure
0 No
1 Yes

High Cholesterol
0 No
1 Yes

Eating disorder (Anorexia or Bulimia Nervosa)
0 No
1 Yes

Anything else you would like to tell us about? [please specify]_____
0 No
1 Yes

12. Has your mother ever been diagnosed with Postnatal Depression?
0 No
1 Yes
2 unsure

13. Do you currently smoke?
0 No
1 Yes

[IF NO] **have you ever smoked?**
0 No
1 Yes

14. Before you became pregnant how often did you usually drink alcohol? [READ LIST]

1. never
2. less than once a month
3. less than once a week
4. 1 day a week
5. 2 days a week
6. 3 days a week
7. 4 days a week
8. 5 days a week
9. 6 days a week
10. everyday

15. On a day when you were drinking alcohol, how many standard drinks would you usually have had?

1. one
2. two
3. three

4. four
5. five
6. six
7. seven
8. eight
9. nine
10. ten or more

16. Since you found out that you were pregnant how often do you usually drink alcohol? [READ LIST]

1. never
2. less than once a month
3. less than once a week
4. 1 day a week
5. 2 days a week
6. 3 days a week
7. 4 days a week
8. 5 days a week
9. 6 days a week
10. everyday

17. Since you found out you were pregnant, on a day when you are drinking alcohol, how many standard drinks would you usually have?

1. one
2. two
3. three
4. four
5. five
6. six
7. seven
8. eight
9. nine
10. ten or more

18. <u>How many times</u> have you seen a General Practitioner (GP) or other health care professional for your <u>OWN</u> health in the last 6 months? [DO NOT READ LIST]

1. one
2. two
3. three
4. four
5. five
6. six or more

19. Has a doctor or other health professional ever talked with you about your PHYSICAL ACTIVITY OR EXERCISE?

0 No
1 Yes

[IF YES] **what did they advise?**_____

20. If you wanted help or advice on how to be more physically active, what sort of help would you prefer? I will read from a list and if you could tell me for each if you would like to receive help in that way or not. [READ LIST]

Advice from a doctor or other Health Professional
0 No
1 Yes

A group of people to be active with
0 No
1 Yes

Advice from a health professional over the telephone
0 No
1 Yes

A videotape to follow at home
0 No
1 Yes

A book on how to start being more active
0 No
1 Yes

A program or advice sent to you via the post (mail)
0 No
1 Yes

A program or advice sent to you via Email
0 No
1 Yes

A program or advice provided through the Internet
0 No
1 Yes

Other [PLEASE SPECIFY]_____
0 No
1 Yes

21. If you wanted to do more physical activity, which three of the following activities would you prefer to do? [READ FROM THE LIST AND PLACE A TICK AGAINST THE THREE PREFERRED ACTIVITIES]

In which order would you rank [LIST 3 PREFERRED ACTIVITIES] **in terms of the activities you would prefer to do?** [NUMBER PREFERENCES]

[FOR EACH OF THE THREE PREFERED ACTIVITIES, ASK WHO PARTICPANT WOULD LIKE TO DO THIS ACTIVITY WITH, AT WHAT TIME OF DAY AND IF THEY WOULD PREFER TO DO IT WITH/WITHOUT THEIR CHILDREN]

	Which 3 of the following Physical Activities would you prefer to do	**Who would you prefer to do this activity with** [read list]	**What time of day would you prefer to do this activity** [read list]	**Would you prefer to do this activity with or without your child(ren)**
	Walking	1 Alone 2 With one other person 3 In a group of people 4 Other _____	1 Morning 2 Middle of the day 3 Afternoon 4 Evening	1 With my child(ren) 2 Without my child(ren)
	Swimming	1 Alone 2 With one other person 3 In a group of people 4 Other _____	1 Morning 2 Middle of the day 3 Afternoon 4 Evening	1 With my child(ren) 2 Without my child(ren)
	Cycling	1 Alone 2 With one other person 3 In a group of people 4 Other _____	1 Morning 2 Middle of the day 3 Afternoon 4 Evening	1 With my child(ren) 2 Without my child(ren)
	Gym (organised classes)	1 Alone 2 With one other person 3 In a group of people 4 Other _____	1 Morning 2 Middle of the day 3 Afternoon 4 Evening	1 With my child(ren) 2 Without my child(ren)
	Gym (individual weight or cardio work)	1 Alone 2 With one other person 3 In a group of people 4 Other _____	1 Morning 2 Middle of the day 3 Afternoon 4 Evening	1 With my child(ren) 2 Without my child(ren)

Section C

Introduce this section by saying:
In this section we would like to ask you about your <u>PREVIOUS</u> pregnancies and births. These questions may be a little personal, but we hope that you can still share your answers with us.

22. How many times have you been pregnant prior to this pregnancy? [RECORD NUMBER]_____

23. These questions are about the births of your children, please answer for all pregnancies that resulted in a birth, including still birth or live birth, starting with your first birth.

[FOR EACH BIRTH ASK THE FOLLOWING QUESTIONS IN EACH COLUMN HEADER AND COMPLETE THE TABLE BELOW]

What was your baby's date of birth	Was the baby a boy or girl	How long was the pregnancy in weeks	How much did your baby weigh (gm or pounds & ounces)	Where did you deliver this baby	What kind of delivery was it	Did you breast-feed this baby	[If YES], for how long did you breast-feed	Did you have postnatal depression	[If YES] what treatment did you receive
1.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1. Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1. Vaginal 2. Assisted vaginal 3. Caesarean	0. No 1. Yes	_____wks _____months _____years	0. No 1. Yes	
2.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1. Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1. Vaginal 2. Assisted vaginal 3. Caesarean	1. No 2. Yes	_____wks _____months _____years	0. No 1. Yes	
3.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1. Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1. Vaginal 2. Assisted vaginal 3. Caesarean	1.No 2.Yes	_____wks _____months _____years	1. No 2. Yes	

this table is continued on the next page……

What was your baby's date of birth	Was the baby a boy or girl	How long was the pregnancy in weeks	How much did your baby weigh (gm or pounds & ounces)	Where did you deliver this baby	What kind of delivery was it	Did you breast-feed this baby	[If YES], for how long did you breast-feed	Did you have postnatal depression	[If YES] what treatment did you receive
4.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1. Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1.Vaginal 2. Assisted vaginal 3. Caesarean	0. No 1. Yes	_____wks _____months _____years	0. No 1. Yes	
5.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1. Public Hospital 2.Private Hospital 3. Home 4. Another birthing facility	1. Vaginal 2. Assisted vaginal 3. Caesarean	0. No 1. Yes	_____wks _____months _____years	0. No 1. Yes	
6.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1.Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1.Vaginal Assisted 2. vaginal 3. Caesarean	0. No 1. Yes	_____wks _____months _____years	0. No 1. Yes	
7.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1.Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1.Vaginal 2. Assisted vaginal 3. Caesarean	0. No 1. Yes	_____wks _____months _____years	0. No 1. Yes	
8.	1. Boy 2. Girl		_____gm OR _____lb _____oz	1. Public Hospital 2. Private Hospital 3. Home 4. Another birthing facility	1. Vaginal 2. Assisted vaginal 3. Caesarean	0. No 1. Yes	_____wks _____months _____years	0. No 1. Yes	

Section D

Introduce this section by saying:
This section is about your physical activity.

The following questions are about the physical activity you used to do BEFORE your current pregnancy

25. How many times a week did you usually do at least 20 minutes or more of VIGOROUS-intensity physical activity that made you sweat or puff and pant? (e.g., heavy lifting, digging, jogging, aerobics, or fast bicycling.) [Do NOT READ LIST]

1. none
2. once a week
3. twice a week
4. three times a week or more

What types of vigorous activities did you do? [RECORD RESPONSE]_____
_____

26. How many times a week did you usually do at least 30 minutes or more of MODERATE-intensity physical activity or WALKING that increased your heart rate or made you breath harder than normal? (e.g., walking for exercise, carrying light loads, bicycling, doubles tennis.) [DO NOT READ LIST]

1. none
2. once a week
3. twice a week
4. three times a week
5. four times a week
6. five or more times a week

What types of moderate activities did you do? [RECORD RESPONSE]_____
_____

27. How often during the past week did you do each of the following activities.

Climbed the stairs instead of using lift or escalator. Would you say…

1. all the time
2. often
3. sometimes
4. hardly ever
5. never
6. not applicable

Parked your car further away from your destinations so that you had to walk further. Would you say…

1. all the time
2. often
3. sometimes
4. hardly ever
5. never
6. not applicable

Walk or ride a bicycle to destinations that are within a short distance from where you live, rather than drive? Would you say…

1. all the time
2. often
3. sometimes
4. hardly ever
5. never
6. not applicable

Get off the bus or train at a stop which is not the one nearest to your destination? Would you say…

1. all the time
2. often
3. sometimes
4. hardly ever
5. never
6. not applicable

28. Next is a list of ways people may react to someone who is trying to do physical activity. I will ask you to tell me how often your <u>PARTNER</u> has said or done the following in the past 3 months.
[IF PARTICIPANT DOES NOT HAVE A PARTNER, ENTER 'none' here]_____
_____

In the past three months, how often has your partner…

Given you encouragement to engage in physical activity

1. never
2. rarely
3. sometimes
4. often

Offered to be physically active with you

1. never
2. rarely
3. sometimes
4. often

Helped plan activities around your physical activity

1. never
2. rarely
3. sometimes
4. often

Taken over chores so you had more time to be physically active

1. never
2. rarely
3. sometimes
4. often

Offered to mind the children so you could be more physically active

1. never
2. rarely
3. sometimes
4. often

Section E

Introduce this section by saying:
This section is about how you have been feeling lately

29. I will read some statements that describe how people can feel. For each statement I will ask you to tell me how well that statement described how you have been feeling lately. Do not think about each answer too much, please give your immediate response.

I feel tense or 'wound up'. Would you say…

1. Most of the time
2. A lot of the time
3. From time to time, occasionally
4. Not at all

I still enjoy the things I used to enjoy Would you say…

1. Definitely as much
2. Not quite as much
3. Only a little
4. Hardly at all

I get a sort of frightened feeling as if something awful is about to happen. Would you say…

1. Very definitely and quite badly
2. Yes, but not too badly
3. A little, but it doesn't worry me
4. Not at all

I can laugh and see the funny side of things. Would you say…

1. As much as I always could
2. Not quite so much now
3. Definitely not so much now
4. Not at all

Worrying thoughts go through my mind. Would you say…

1. A great deal of the time
2. A lot of the time
3. From time to time, but not too often
4. Only occasionally

I feel cheerful. Would you say…

1. Not at all
2. Not often
3. Sometimes
4. Most of the time

I can sit at ease and feel relaxed. Would you say…

1. Definitely
2. Usually
3. Not often
4. Not al all

I feel as if I am slowed down. Would you say…

1. Nearly all the time
2. Very often
3. Sometimes
4. Not at all

I get a sort of frightened feeling like 'butterflies' in the stomach. Would you say…

1. Not at all
2. Occasionally
3. Quite often
4. Very often

I have lost interest in my appearance. Would you say…

1. Definitely
2. I don't take as much care as I should
3. I may not take quite as much care
4. I take just as much care as ever

I feel restless as if I have to be on the move. Would you say…

1. Very much indeed
2. Quite a lot
3. Not very much
4. Not at all

I look forward with enjoyment to things. Would you say…

1. As much as I ever did
2. Rather less than I used to
3. Definitely less than I used to
4. Hardly at all

I get sudden feelings of panic. Would you say…

1. Very often indeed
2. Quite often
3. Not very often
4. Not at all

I can enjoy a good book or radio or TV program. Would you say…

1. Often
2. Sometimes
3. Not often
4. Very seldom

30. The next questions are about social support. For each of the following statements, I will ask you how you feel about the support you have right now.

I have good friends who support me

1. always
2. most of the time
3. some of the time
4. rarely
5. never

My family is always there for me

1. always
2. most of the time
3. some of the time
4. rarely
5. never

My husband/partner helps me a lot

1. always
2. most of the time
3. some of the time
4. rarely

5. never

There is conflict with my husband/partner

1. always
2. most of the time
3. some of the time
4. rarely
5. never

I feel controlled by my husband/partner

1. always
2. most of the time
3. some of the time
4. rarely
5. never

I feel loved by my husband/partner

1. always
2. most of the time
3. some of the time
4. rarely
5. never

Follow-Up Questions

31. Would you consent to being followed up for telephone interviews post-pregnancy at 2, 4 and 6 months intervals?

0. No
1. Yes

[ALSO TELL PARTICPANT]: **Because this is the pilot phase of the project, follow-up will not be conducted at this stage, but thank you for your interest.**

32. Would you mind being re-contacted about similar research projects in the future?

0. No
1. Yes

[IF YES ASK PARTICPANT FOR]:

Date of Birth:____/____/____

Name: _____

Address:_____

Postcode:_____

Telephone:(Home)_____**(Work)**_____**(Mobile)**_____

Email:_____

APPENDIX D: HOSPITAL RECORD DATA EXTRACTION SHEET

Date of Data Extraction

Hospital ID Number		**REQUEST NUMBER**	

PRENATAL SOCIAL SUPPORT **0=NO** **1=YES** **2=MISSING** **1a & 3a =TEXT**	1	Do you receive a pension/benefit?		Comments?
	1a	What kind?		
	2	Did you receive learning support at school or attend a special school?		
	3	Do other services support you or your partner?		
	3a	Which ones?		
	4	Do you have friends that are helpful?		
	5	Will your friends help you when the baby is born?		
	6	Do you think your partner will help you with this baby?		
	7	Do you manage your own money?		
	8	Do you feel loved by your husband/partner?		
DOMESTIC VIOLENCE **0=NO** **1=YES** **2=MISSING**	1	Are you ever afraid of your partner?		If yes to any previous Q's
	2	In the last year, has anyone at home hit, kicked, punched or otherwise hurt you?		Would you like help with any of this now?
	3	In the last year has anyone at home often put you down, humiliated you or tried to control what you can do?		This could be important information for your healthcare. May we send a copy of this to your own doctor?
	4	In the last year, has your partner threatened to hurt you?		

DV Action		**DV Information**	
Declined assistance at this time		Patient declined information at this time	
Referred to social work department		No information required	
Referred to other agency or proc		Helpline #	
Other		Information on DV	
		Other	

Gravida (No. of pregnancies)		**Gender**	
This baby: 0,live;1,still;2,missing info		**PND B4 this birth**	
No. of Terminations		**Baby's DOB**	
No. of Miscarriages		**Baby's Weight**	
No. of Still Births		**Gestation period**	
No. of Live births (inc this one)		**Apgar(s)**	
Position mum in del		**Tears/Complications**	
SVD/C/S/Assisted		**PND noted later birth**	

APPENDIX E: HOSPITAL ANXIETY AND DEPRESSION SCALE (HADS)

I feel tense or wound up:		A	**I feel as if I am slowed down:**	D	
Most of the time		3	Nearly all the time	3	
A lot of the time		2	Very often	2	
Time to time		1	Sometimes	1	
Not at all		0	Not at all	0	
I still enjoy the things I used to enjoy:	D		**I get a sort of frightened feeling like butterflies in the stomach:**		A
Definitely as much	0		Not at all		0
Not quite so much	1		Occasionally		1
Only a little	2		Quite often		2
Hardly at all	3		Very often		3
I get a sort of frightened feeling as if something awful is about to happen:		A		D	
Very definitely and quite badly		3	Definitely	3	
Yes, but not too badly		2	I don't take so much care as I should	2	
A little, but it doesn't worry me		1	I may not take quite as much care	1	
Not at all		0	I take just as much care as ever	0	
I can laugh and see the funny side of things:	D		I feel restless as if I have to be on the move:		A
As much as I always could	3		Very much indeed		3
Not quite as much now	2		Quite a lot		2
Definitely not so much now	1		Not very much		1
Not at all	0		Not at all		0
Worrying thoughts go through my mind:		A	**I look forward with enjoyment to things:**	D	
A great deal of the time		3	As much as ever I did	0	
A lot of the time		2	Rather less than I used to	1	
From time to time but not too often		1	Definitely less than I used to	2	
Only occasionally		0	Hardly at all	3	
I feel cheerful:	D		**I get sudden feelings of panic:**		A
Not at all	3		Very often indeed		3
Not often	2		Quite often		2
Sometimes	1		Not very often		1
Most of the time	0		Not at all		0
I can sit at ease and feel relaxed:		A	**I can enjoy a good book or radio or TV programme:**	D	
Definitely		0	Often	0	
Usually		1	Sometimes	1	
Not often		2	Not often	2	
Not at all		3	Very seldom	3	

Questions relating to anxiety are indicated by an 'A' while those relating to depression are shown by a 'D'. Scores of 0-7 in respective subscales are considered normal, with 8-10 possible case and 11 or over indicating probable clinical case.

APPENDIX F: DOMESTIC VIOLENCE QUESTIONS ASKED BY HOSPITAL STAFF AT PARTICIPANTS' ANTENATAL CARE INTERVIEW

1. Are you ever afraid of your partner?
2. In the last year, has anyone at home hit, kicked, punched or otherwise hurt you?
3. In the last year has anyone at home often put you down, humiliated you or tried to control what you can do?
4. In the last year, has your partner threatened to hurt you?

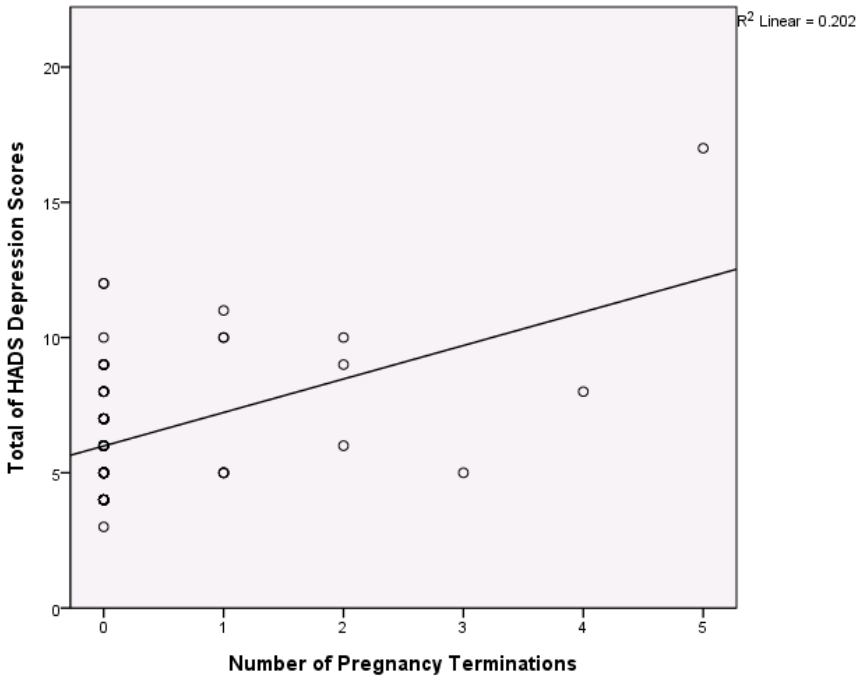
APPENDIX G: MATERNAL SOCIAL SUPPORT SCALE

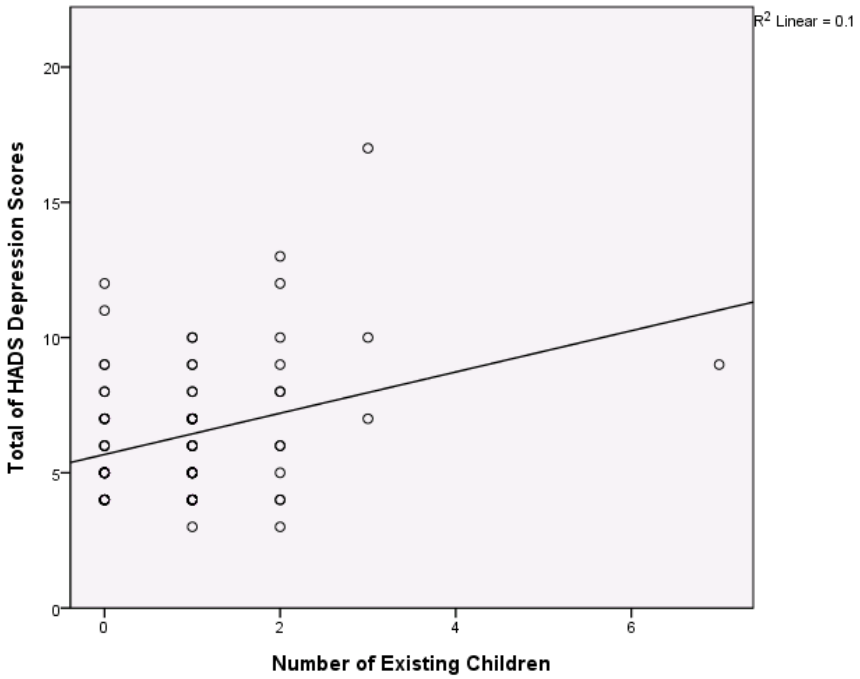
The Royal Women's Hospital, Brisbane
MATERNITY SOCIAL SUPPORT SCALE (MSSS)

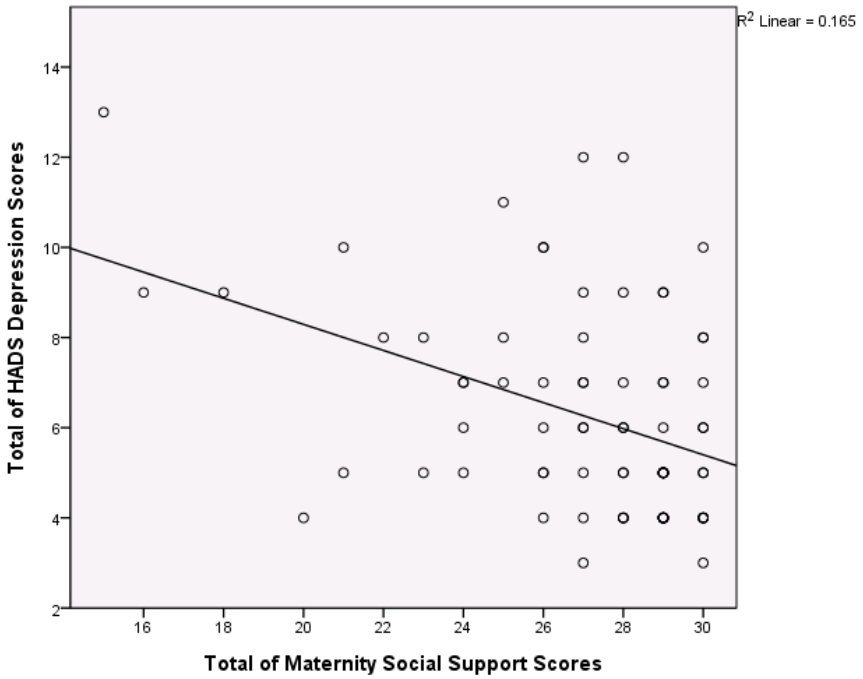
For each of the following statements, please tick one box which shows how you feel about the support you have right now	Always	Most of the time	Some of the time	Rarely	Never
A. I have good friends who support me	5	4	3	2	1
B. My family is always there for me	5	4	3	2	1
C. My husband/partner helps me a lot	5	4	3	2	1
D. There is conflict with my husband/partner	1	2	3	4	5
E. I feel controlled by my husband/partner	1	2	3	4	5
F. I feel loved by my husband/partner	5	4	3	2	1

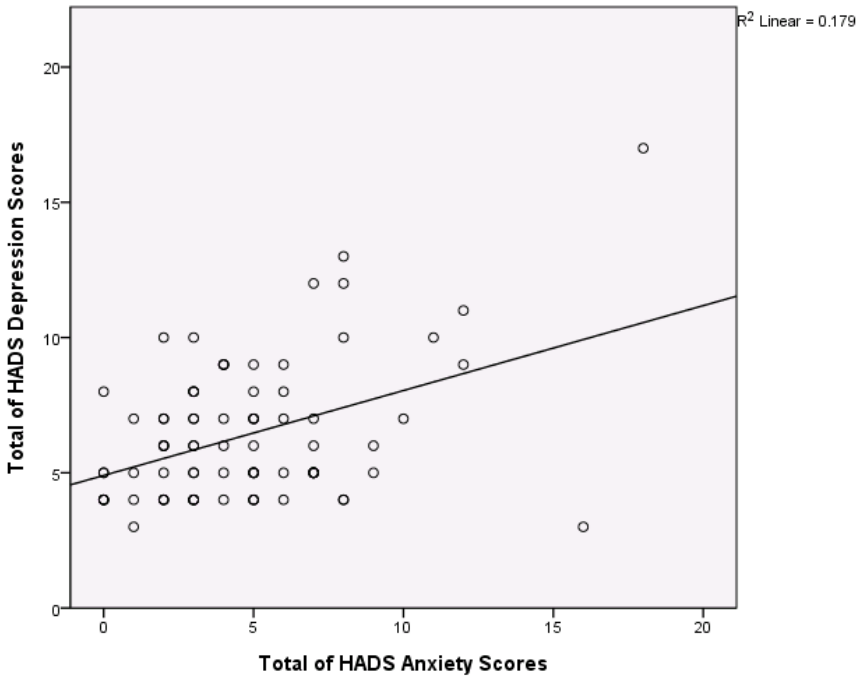
TOTAL SCORE ☐

APPENDIX H: SCATTERPLOTS USED TO CONFIRM LINEAR RELATIONSHIP BETWEEN POTENTIAL COVARIATES AND DEPENDENT VARIABLE

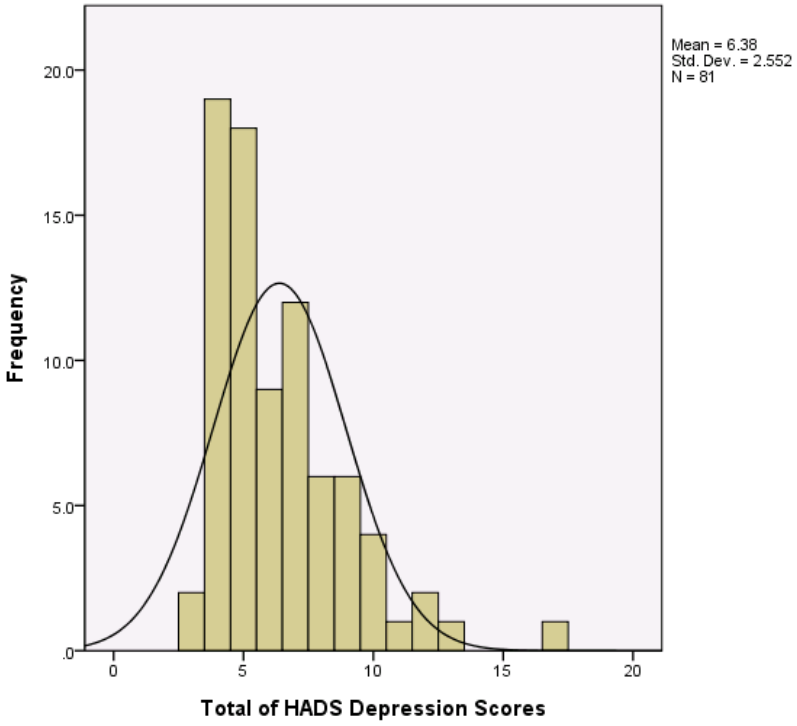


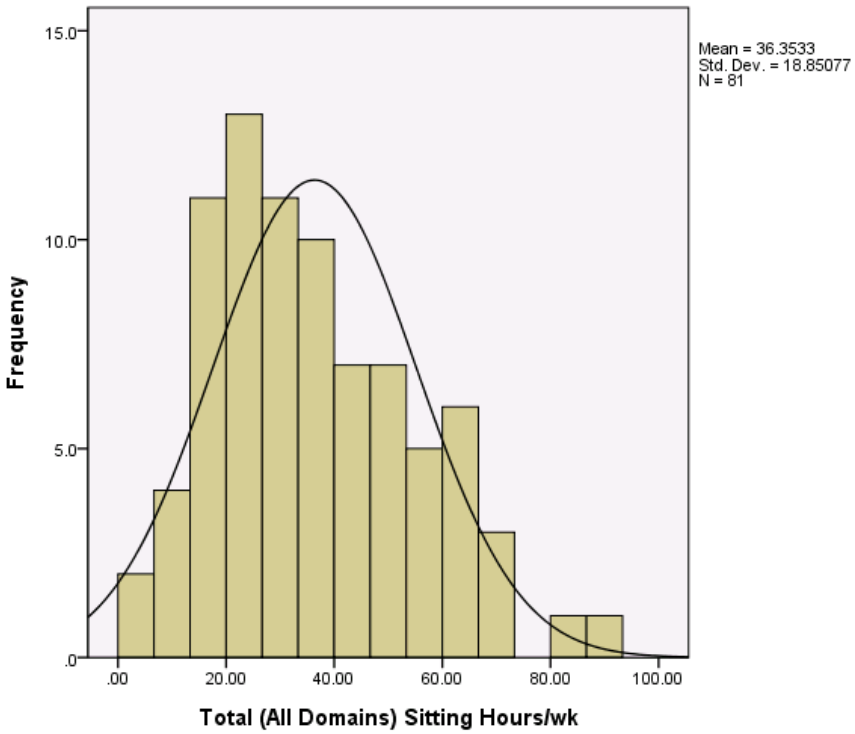


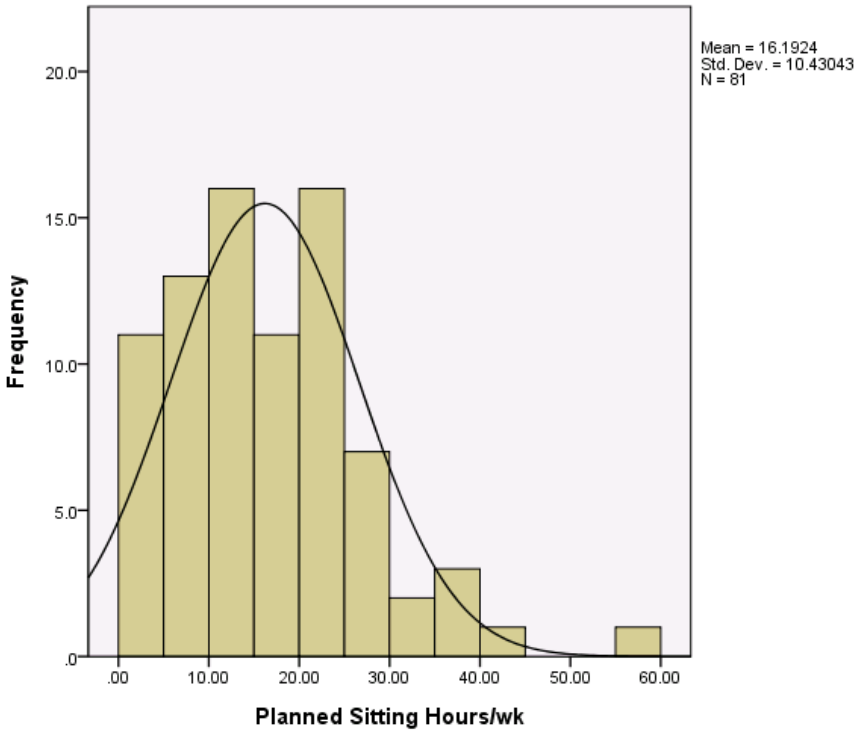

R² Linear = 0.165
Total of HADS Depression Scores
Total of Maternity Social Support Scores
14
12
10
8
6
4
2
16
18
20
22
24
26
28
30


R² Linear = 0.179
Total of HADS Depression Scores
Total of HADS Anxiety Scores
20
15
10
5
0
0
5
10
15
20

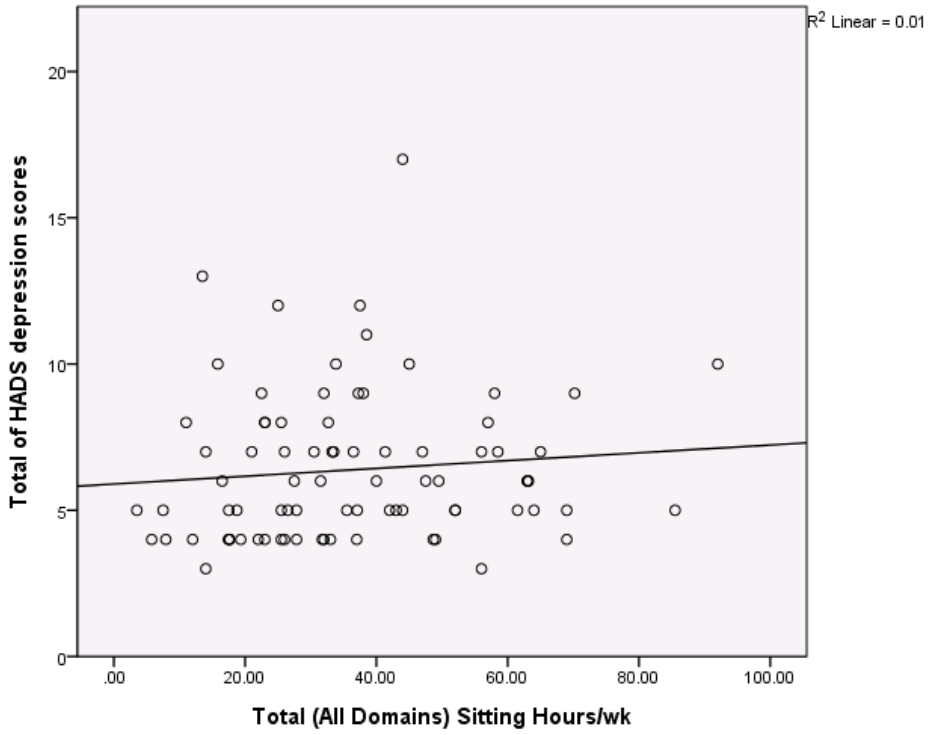
APPENDIX I: UNIVARIATE ANALYSIS HISTOGRAMS OF DEPRESSIVE SYMPTOM SCORES, TOTAL SITTING TIME AND PLANNED SITTING TIME DISTRIBUTIONS

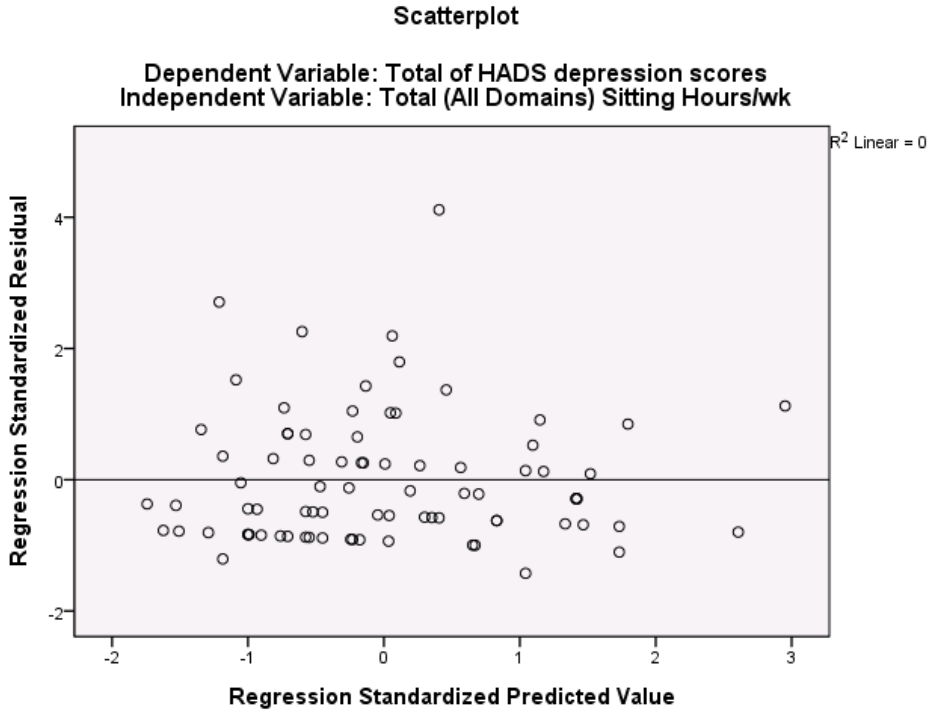


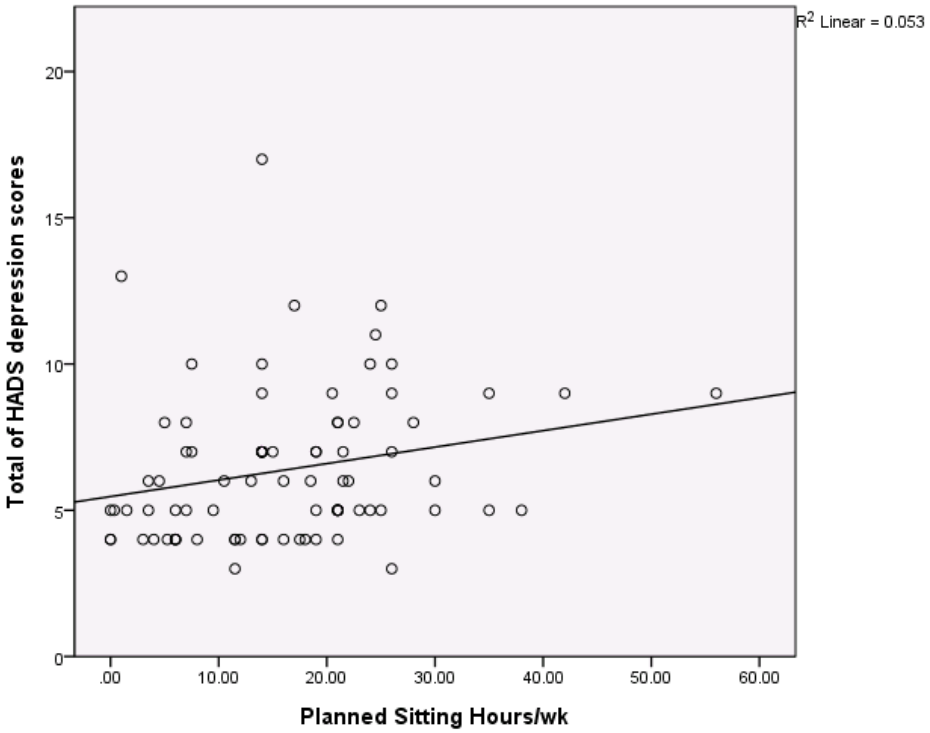



Mean = 16.1924
Std. Dev. = 10.43043
N = 81
Frequency
20.0
15.0
10.0
5.0
.0
.00
10.00
20.00
30.00
40.00
50.00
60.00
Planned Sitting Hours/wk

APPENDIX J: SCATTER PLOTS CONFIRMING THE ABSENCE OF NON-LINEAR RELATIONSHIPS BETWEEN SITTING VARIABLES AND HADS-D DEPRESSSIVE SYMPTOM SCORES







Scatterplot

Dependent Variable: Total of HADS depression scores
Independent Variable: Planned Sitting Hours/wk