Hypertension and common mental disorders in a nationally-representative sample of South African adults

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DECLARATION

I, Anna Grimsrud, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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ABSTRACT

Background: Growing evidence suggests high levels of comorbidity between chronic physical conditions and mental illness, mainly anxiety and depression. Previous studies present mixed evidence on the association of hypertension with anxiety and depression. These studies are primarily from developed countries and frequently use measures of anxiety and depressive symptoms rather than diagnoses of anxiety and depressive disorders. In addition, few studies have adjusted for the comorbidity with other chronic physical conditions or exposure to traumatic life events. This thesis examines the associations between self-reported hypertension diagnosis and Diagnostic and Statistical Manual of Mental Disorders 4th edition (*DSM-IV*) defined a) anxiety disorders b) depressive disorders and c) comorbid anxiety-depression, both lifetime and 12-month, adjusting for potential confounding variables.

Methods: Data were drawn from the South African Stress & Health Survey (SASH) which was conducted as part of the World Mental Health Initiative to provide data on the prevalence of and risk factors for *DSM-IV* disorders in a nationally-representative sample. A total of 4351 individuals were sampled and the overall response rate was 87%. Mental disorders were assessed using the World Mental Health pencil and paper version of the World Health Organization Composite International Diagnostic Interview Version 3.0 (CIDI 3.0); hypertension was measured by self-reported lifetime diagnosis by a doctor or other health professional. Information on other chronic physical conditions experienced in the past 12-months and lifetime diagnosis of other chronic physical conditions by a health care professional was also ascertained. In addition to hypertension, fourteen other chronic physical conditions were examined including vascular (e.g. diabetes, heart attack) and non-vascular (e.g. arthritis, lung disease) conditions. Data on the number of traumatic life events were obtained from the screening for posttraumatic stress disorder. The relationships between self-reported hypertension and lifetime and 12-month a) anxiety disorders, b) depressive disorders

and c) comorbid anxiety-depression were assessed both in bivariate associations and multivariate analysis adjusting for potential confounders.

Results: The mean age of the sample was 37 years, with 54% being female and 74% having completed at least some high school. Of the total sample, 17% reported a lifetime diagnosis of hypertension, 16% had a lifetime anxiety disorder, 12% had a lifetime depressive disorder and 4% had comorbid anxiety-depression. An increased prevalence of hypertension diagnosis was found in those with anxiety disorders (23%), depressive disorders (20%) and comorbid anxiety-depression (22%) compared to those without mental disorders (15%) in bivariate analysis. In multivariate analysis, hypertension diagnosis was associated with anxiety disorders (OR=1.38, 95% CI=1.07-1.79) but not depressive disorders or comorbid anxiety-depression after adjusting for demographics, socioeconomic status, smoking and alcohol use, substance use disorders and traumatic life events. In subsequent multivariate analysis, hypertension alone was not associated with any of the mental health outcomes (lifetime anxiety disorders OR=1.13, 95% CI=0.63-2.18, lifetime depressive disorders OR=0.83, 95% CI=0.45-1.50, lifetime comorbid anxiety-depression OR=0.75, 95% CI=0.26-2.19) while hypertension and another chronic physical condition were associated with lifetime anxiety disorders (OR=1.92, 95% CI=1.41-2.63), depressive disorders (OR=1.46, 95% CI=1.06-2.03), and comorbid anxiety-depression (OR=1.77, 95% CI=1.06-2.38). Traumatic life events were a strong independent predictor of anxiety disorders (OR=1.50-2.58), depressive disorders (OR=1.98-3.68) and comorbid-depression (OR=1.66-4.31) and so was female sex (e.g. lifetime anxiety disorders OR=2.47, 95% CI=1.91-3.19).

Conclusions: Hypertension was not associated with any mental health outcome after adjusting for demographics, socioeconomic status, smoking and alcohol use, substance use disorders, traumatic life events, and other chronic physical conditions. In these data it appears that

chronic physical conditions are a complete confounder in the hypertension and anxiety/depressive disorder relationship. Further investigations into the temporality and the role of comorbid conditions in the hypertension and anxiety/depressive disorder relationship should remain a priority. Increased efforts should be made for early detection and control of hypertension as this can prevent development of subsequent chronic physical conditions and therefore prevent a proportion of anxiety and depressive disorders. Due to the high levels of physical-mental comorbidity, screening of mental disorders requires greater attention alongside of screening for chronic physical conditions.

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ABBREVIATIONS

BMI	Body Mass Index
BOD	Burden of Disease
CHD	Coronary Heart Disease
CI	Confidence Interval
CIDI 3.0	Composite International Diagnostic Interview Version 3.0
CRA	Comparative Risk Assessment
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Year
DBP	Diastolic Blood Pressure
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association, 4th edition
EA	Enumerator Area
GBD	Global Burden of Disease
ICD	WHO International Statistical Classification of Diseases and Related Health Problems
mm Hg	Millimetres of mercury
OR	Odds ratio
PSU	Primary stage Sampling Units
RR	Relative Risk
SADHS	South African Demographic and Health Survey
SADS	Schedule for Affective Disorders and Schizophrenia
SASH	South African Stress & Health study
SBP	Systolic Blood Pressure
SCID	Structured Clinical Interview for *DSM-IV*
UCT	University of Cape Town
WHO	World Health Organization
WHR	World Health Report
WMH	World Mental Health
YLD	Years of Life with Disability
YLL	Years of Life Lost

1 INTRODUCTION

South Africa faces unique challenges reflecting a complex burden of disease with high rates of infectious diseases (including HIV/AIDS) and an emerging chronic disease epidemic (1). There is limited acknowledgement of the major contribution of chronic diseases despite the reality that 41% of mortality in the country is attributable to chronic disease (2). Worldwide it is estimated that there will be a 77% increase in deaths from chronic disease between 1990 and 2020 with the majority of deaths taking place in the developing world (3).

Chronic conditions, including mental disorders and hypertension, are a major cause of mortality and morbidity but receive relatively little attention in the developing world. Hypertension is the leading risk factor for mortality accounting for approximately 6% of global deaths (4, 5). In addition it is a major risk factor for other chronic physical conditions including strokes, heart attacks, and kidney failure (2). Data from the 1998 Demographic and Health Survey revealed that 21% of South African adults were hypertensive, with a systolic blood pressure of greater than or equal to 140 mm Hg or a diastolic blood pressure of greater than or equal to 90mm Hg (6).

Mental disorders, including anxiety and depressive disorders are also associated with high levels of morbidity and years of life lost. Unipolar depression causes the largest amount of non-fatal burden worldwide, attributable for 12% of the total years lived with disability (YLD) (7, 8). Recent data from a nationally-representative mental health survey found a high prevalence of mental disorders in South Africa reporting that 16% of adults had an anxiety disorder and 10% had major depression (9).

There is a growing body of evidence investigating the comorbidity of physical and mental health. Individuals with mental disorders are generally of poorer physical health that those without mental illness (10). A substantive literature highlights the increased prevalence of chronic physical conditions among those with mental disorders. This increased prevalence has been demonstrated for a number of different mental disorders. However, because the majority of the literature is cross-sectional and the date of the onset of the chronic disease is often unknown, it is unclear as to whether the onset of mental disorder precedes or follows the chronic disease. Also, there is uncertainty as to how mental and physical health are associated; if the relationship is causal or rather co-occurring as a result of a confounder such as low socioeconomic status.

Hypertension, anxiety disorders and depressive disorders are hypothesized to have high prevalence and comorbidity in the developing world but their prevalence and associations remain largely unmeasured and untreated (7). Evidence from developed countries shows a high level of physical-mental comorbidity with anxiety and depressive disorders more common in those with hypertension. Previous research has hypothesized that the physiological changes resulting from anxiety and depressive disorders increase the likelihood of developing hypertension. Conversely, it has been proposed that the diagnosis of hypertension may cause an increase in stress that leads to the development of anxiety and/or depressive disorders. There is mixed evidence on the directionality and strength of the association between hypertension and anxiety and depressive disorders. Furthermore, little evidence from developing countries exists on the potential physical-mental comorbidity or nature of the association. Also, there is limited research of the association between comorbid anxiety-depression and hypertension (mental and physical-mental comorbidity).

This thesis examines the associations between hypertension diagnosis and Diagnostic and Statistical Manual of Mental Disorders 4th edition (*DSM-IV*) defined anxiety disorders, depressive disorders, and comorbid anxiety-depression in a nationally-representative sample of South African adults. The relationships are investigated along with data on demographic and socioeconomic risk factors, substance use disorders, traumatic life events and other chronic physical conditions.

The aim of this study is to understand the relationships between hypertension diagnosis and a) anxiety disorders b) depressive disorders and c) comorbid-anxiety depression in South Africa. The specific objectives of this study are to:

1. Describe the prevalence and characteristics of those with hypertension (self-reported lifetime diagnosis) including the demographic, socioeconomic and other variables including other chronic physical conditions and traumatic life events;

2. Describe the prevalence and characteristics of those with *DSM-IV* a) anxiety disorders, b) depressive disorders and c) comorbid anxiety-depression, including the demographic, socioeconomic, other characteristics and comorbidity with chronic physical conditions including hypertension

3. Explore the independent associations between hypertension and those with *DSM-IV*-defined
   a) anxiety disorders,
   b) depressive disorders and
   c) comorbid anxiety-depression,

   both lifetime and 12-month, after adjusting for potential confounding variables.

2 LITERATURE REVIEW

2.1 Search Strategy

The MEDLINE (PubMed) database was searched for articles interchanging keywords from two categories: 1) hypertension, including "hypertension", and "blood pressure" and 2) mental health, including "anxiety*", "depression", "mental health", "stress", "psychosocial". The studies were restricted to those studies in human beings published in English between January 1, 1980 and June 20, 2007. This search strategy was then expanded to include a third category: 3) chronic disease, including the key word "chronic*". Abstracts were screened and evaluated and then full texts for included articles were found. Additional articles were found manually using references cited in included studies.

2.2 Epidemiology of Hypertension

Hypertension is a condition of elevated blood pressure. The definition of hypertension in relation to cut-off points has changed over time and varies within countries (6). Currently, the International Society of Hypertension defines essential hypertension as a systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg, or current treatment with antihypertensive medication (14)[1].

Hypertension is one of the most common modifiable risk factors for cardiovascular and renal diseases (6, 11-14). There is a large literature on the risk factors for hypertension, focusing largely on developed-country populations. Hypertension is associated with a number of factors including age, sex, race, socioeconomic status, nutrition, alcohol consumption, physical inactivity, and adoption of a western lifestyle (11). The focus of identifying risk factors has been on biological and physical factors, and less attention on the potential role of psychosocial factors such as stress.

[1] This is the definition of hypertension used throughout this paper (≥140/90mm Hg).

2.3 Epidemiology of Common Mental Disorders: Anxiety and Depression

Knowledge of the distribution and determinants of mental health in the developing country context is limited, with the large majority of the literature coming from Europe and North America. A brief summary of the epidemiology of anxiety, depressive and comorbid anxiety-depressive disorders is provided below.

Although there are a number of different specific anxiety disorders, they all share the two components of experiencing anxiety: physiological sensations and awareness of being apprehensive or scared. Anxiety disorders are the most prevalent psychiatric conditions and have high morbidity. A growing body of evidence suggests they are associated with cardiovascular disease. Women are more likely than men to have an anxiety disorder, and socioeconomic status is often inversely related to prevalence of anxiety disorders (15).

Depression is classified as a mood or affective disorder characterised by sustained emotional states and is therefore most appropriately considered a syndrome that is often reoccurring or cyclical. Depression is common, with a much higher prevalence in women compared to men. Marital status has been shown to be associated with depression, where those without close interpersonal relationships or those who are divorced or separated are more likely to have depression (15).

It is now well established that there is significant comorbidity of mental disorders, including the co-occurrence of anxiety and depressive disorders. (7). This co-occurrence is sometimes referred to as comorbid depression-anxiety (16) or cothymia (mixed anxiety-depression) (18). Population surveys have reported that about half those with a current mood disorder also have an anxiety disorder (16, 19). Previous research has hypothesized that individuals with comorbid depression-anxiety have increased role impairment and risk for chronic physical

conditions compared to those with non-comorbid anxiety or non-comorbid depression (16, 18, 20).

2.4 Physical-Mental Comorbidity

The significant comorbidity of chronic physical conditions and mental health is confirmed from general population samples, primary care samples and clinical studies (16, 21-25). This co-occurrence has been referred to as physical-mental comorbidity or psychiatric-medical comorbidity (24, 25). Co-occurrence is also increasingly common with age and therefore, comorbidity will be more prevalent in aging societies (7).

There is a growing understanding and acceptability of the psychobiological underpinnings of anxiety and depressive disorders and an increased interest in possible psychosocial risk factors for hypertension (26). Because hypertension is asymptomatic, studying the relationship of hypertension with mental disorders offers the unique opportunity to see if the association is due to psychosocial factors such as stress, or biological changes such as increased sympathetic activity. There is inconclusive evidence regarding the directionality of this relationship; whether hypertension precedes or follows the onset of mental disorders. Prospective studies of incident hypertension investigate the hypothesis that a mental disorder is a risk factor for hypertension and find mixed evidence of an association (13, 27-31). Cross-sectional studies have also looked at age of onset and found it more common for hypertension to precede a mental disorder (31). Furthermore, other research suggests that the relationship may be bi-directional through a combination of both biological and psychosocial mechanisms (16).

2.5 Burden of disease

To summarize the prevalence and burden of hypertension, anxiety disorders and depressive disorders, global and South African figures are presented below.

2.5.1 Hypertension

In 2005, 60% of deaths worldwide were attributable to chronic disease with 80% of these occurring in developing countries (32). The Global Burden of Disease study ranked hypertension as the leading cause of mortality attributable for a total of 7.1 million deaths in 2005 (32, 33). In addition, the Comparative Risk Assessment (CRA) ranked hypertension as the third largest contributor to global morbidity, as measured by disability adjusted life years (DALYs) (33). Global data emphasizes that the prevalence of hypertension is rising rapidly in developing countries, consistent with the pandemic of cardiovascular disease. In 2000, 26.4% of the adult population worldwide was hypertensive, with 26.6% of men and 26.1% of women with hypertension (34).

In South Africa, hypertension is not in the top 20 specific causes of premature mortality burden, but is identified as the eighth leading risk factor for morbidity, attributable for 2.4% of the total disability adjusted life years (DALYs) (1, 35). Furthermore, in the Revised Burden of Disease Study published in 2006, hypertension is the 10th leading cause of years of life lost (YLLs), attributable for 1.3% of the total YLL. According to the 1998 South African Demographic and Health Survey (SADHS), the age-adjusted prevalence of hypertension was 21% and the self-reported lifetime diagnosis of hypertension was 19% for women and 8% for men (6)[2].

[2] The prevalence of self-reported hypertension is reported twice in the 1998 SADHS report, both in Chapters 10 and 12. The prevalence by men and women is different between these two chapters. For the purpose of this study, the prevalences reported by Chapter 10 were used.

2.5.2 Anxiety and Depression

Mental illness is highly prevalent, associated with significant burden, and often under-treated (26). The publication of morbidity figures in Global Burden of Disease (GBD) study highlighted the impact of mental disorders (4, 36). In 2000, depression was the fourth leading cause of burden among all diseases, accounting for 4.4% of total DALYs and caused the largest amount of non-fatal burden, attributable for 11.9% of the total years lived with disability (YLD) (7, 8). Uniploar depression was only the seventh leading cause of burden in men at 3.4% of total DALYs, but the fourth leading cause of disease burden in women at 5.6% of total DALYs (8). The global depression prevalence was estimated at 10.4% (7). The burden of depression is projected to increase. By 2020, 15% of the DALYs and 5.7% of the total burden of disease will be attributable to depression, becoming the second leading cause worldwide (7, 36). Less is known on the burden of anxiety disorders, with an estimated global prevalence of 7.9% (7).

Limited data on the prevalence and burden of mental disorders is available for developing countries including South Africa. The South African Burden of Disease study ranks mental disorders at the 19th contributor for years of life lost (YLL) and 13th for disability-adjusted-life-years (DALYs)(1). Revised estimates place unipolar depression as the 10th cause of disability adjusted life years, attributable for 2.0% of the total DALYs (35). The burden of mental health in South Africa from these figures appears to be small. In addition to hypothesizing under-reporting, the authors suggest that using the Global Burden of Disease category "neuropsychiatric conditions" (which includes mental and nervous system disorders combined) would be more appropriate. Mental disorders would have the second highest DALY ranking if this category was used (1).

2.6 Evidence for an association between hypertension and mental disorders

The first papers on the possible impact of psychosocial factors on blood pressure were published in 1939 (37, 38). A summary of the evidence of associations between hypertension and anxiety, depressive, and comorbid anxiety-depressive disorders is below.

2.6.1 Evidence of an association between hypertension and anxiety disorders

There is mixed evidence for an association between hypertension and anxiety. The evidence is inconsistent across study designs and measures used. Furthermore, the strength of the association is mixed when stratified by age, sex and race.

A number of studies have shown a positive association between hypertension and anxiety in both crude and multivariate analyses (23, 39-42). Early research found an increased prevalence of hypertension in those with anxiety disorders (39). Other studies adjusted for sex, substance abuse, and depression and found that those with a *DSM-III* anxiety disorder were 2.4 times more likely to report a hypertension diagnosis compared to those without an anxiety disorder. The association persisted when stratified by sex (23). A prospective study in the Netherlands found that after controlling for age, sex, socioeconomic status, history of disease, and number of contacts with a family practitioner during follow-up, parents whose children had been fire victims were 1.48 times more likely to develop hypertension compared to those who were not exposed to the disaster-related stress (41).

Conversely, there are studies that show no crude or adjusted association between hypertension and anxiety (13, 43, 44). In a prospective study of normotensive adults in the United States, neither crude analysis nor multiple regression analysis showed a relationship between anxiety and changes in blood pressure (43). Similarly, in a cross-sectional study of young American adults, anxiety did not have a crude or adjusted association with hypertension (44). In the

Coronary Artery Risk Development in Young Adults (CARDIA) Study, a number of psychosocial variables were looked at as potential risk factors for hypertension. After controlling for age, education, BMI, physical activity, alcohol consumption and systolic blood pressure, there was no association between the four categories of anxiety as assessed by Speilberger Trait Anxiety Inventory and development of hypertension (p-value for trend = 0.52) (13). In a prospective study of middle-age Finnish women, hypertension incidence had no crude association with levels of anxiety based on three different anxiety scales. However, after adjustment for body mass index (BMI), baseline systolic blood pressure, and family history of hypertension there was an association with the Framingham Tension Scale, but not with the other two scales (30).

Several studies have observed a positive crude association between hypertension and anxiety disorders that does not persist in multivariate models (45, 46). In a large case-control study to assess clinical comorbidity in the United Kingdom, no difference was found in the prevalence of hypertension between controls and those with anxiety disorders (OR=0.9) after controlling for age, sex, and social class (45). In the Framingham study, anxiety was a univariate predictor of incident hypertension in men, and remained an independent predictor only in middle-aged men (p=0.020) and not among older men. Furthermore, there was no psychological predictor of hypertension in either univariate or multivariate analysis for women (46).

Differences when stratified by sex were seen in other studies. In the study of older adults in France, anxiety had crude associations with hypertension among men only, but after adjustment there was a strong positive association between hypertension and anxiety in both men and women (42). Conversely, in a nationally-representative cross-sectional study in New

Zealand the age-adjusted association between anxiety disorders and self-reported hypertension was not significant when stratified by sex (19).

The evidence is mixed across the study designs. Prospective cohort studies yield conflicting findings. Longitudinal data from the National Health and Nutrition Examination Survey in the United States found high anxiety to a be a predictor of incidence hypertension in whites aged 45 to 64 and blacks aged 25 to 64 and intermediate anxiety to be a predictor of incidence hypertension in whites aged 25-44 in multivariate models (29). However, evidence from the CARDIA study showed no consistent pattern between anxiety and hypertension after adjustment (13). Similarly, evidence from cross-sectional studies is inconsistent. In New Zealand, the age-adjusted prevalence of hypertension was significantly higher ($p<0.01$) among those with any anxiety disorder compared to those without any anxiety disorder (19). Conversely, research from the United Kingdom in 2005 reported no difference in the prevalence of hypertension in those with anxiety disorders compared to those without anxiety disorders (45).

2.6.1a Measures of hypertension & anxiety

To potentially understand the inconsistency of these results, it is important to look at the measures used to assess hypertension and anxiety disorders. Hypertension was assessed in a number of ways including medical records, whether participants were taking antihypertensive medication, or through measurement with cut-offs points ranging from 140/90 to 160/95 and through self-reporting. The measurement of anxiety was similarly diverse with different scales, including the Zung Anxiety Scale (39, 40), the Framingham Tension Scale (30, 47, 48), the Spielberger Trait Anxiety Inventory (13, 30, 42, 44), the General Well-Being Anxiety (GWB-A) subscale (43), the Hospital anxiety and depression scale (49), the Schedule for Affective Disorders and Schizophrenia (SADS) (23), Patient Health Questionnaire (50), a

consultation with a doctor for anxiety (45), structured interviews to obtain *DSM-IV* Anxiety Disorder classification (19), and using a stressful life event as an exposure (41). The implication of using these different measurements is that the results are not completely comparable. The strength of the association may depend on the intensity of the measure of anxiety.

Two studies used self-reported history of hypertension (19, 23). In the USA, a cohort study measured anxiety based on a semi-structured interview (SADS). There was no association between hypertension and anxiety when adjusted for sex and substance use disorder, but with adjustment also for depression the association was significant (OR=2.35, 95% CI=1.06-5.17). However, other risk factors for hypertension, including age, were not controlled for and therefore there may still be confounding the association. The only other study to use *DSM* diagnosis of anxiety also found a strong positive association (19). However, the increased prevalence hypertension among those with anxiety was only adjusted for age, and when the prevalence was stratified by sex, there was no association ($p>0.05$).

2.6.2 Evidence of an association between hypertension and depressive disorders

Compared to the literature on hypertension and anxiety, there is greater inconsistency in the data regarding the relationship between hypertension and depressive disorders. Also, the evidence for an association suggests possible variations when stratified by sex and race.

A handful of studies have suggested that depression is more common among individuals with hypertension. A case-control study in country Portugal concluded that a strong crude positive association between hypertension and depression based on the Beck Depression Inventory (BDI) (39). A cohort study in the United States found that both high and medium levels of depression were associated with incidence hypertension after adjusting for age, physical

activity, alcohol consumption, parental history of hypertension, type 2 diabetes, heart disease, sex, and race. However, the association only persisted in Blacks when stratified by race (27). Results from another American cohort study showed similar results, with both incidence hypertension and treated hypertension associated with depression after controlling for age, sex, education, smoking, BMI, alcohol use and three chronic physical conditions. In this study, the associations were significant in Whites and Blacks (29).

A much larger body of evidence exists to show no association between hypertension and depression (13, 28, 42-44, 51). In the Alameda County study, depression showed a positive crude association with hypertension ($p<0.05$), which persisted only in women after adjustment (28). Eight other studies found no crude or adjusted association between hypertension and depression (13, 19, 31, 42-44, 50, 51).

Findings for the association often vary when stratified by race or sex. Some studies restrict study inclusion to only men or only women as was the case in one American and one Vietnamese cohort study (30, 31). Therefore, it is unclear whether the association is the same for both men and women. There also appears to be an increased association between depressive disorders and hypertension in non-whites. Depression increased the odds of hypertension among blacks only in two American cohort studies (27, 28). In a cross-sectional study using a household survey in Harlem, New York the population was predominantly Black and there was an association between self-reported hypertension and depressive symptoms. Therefore, results differed by race and sex, and future research should stratify and adjust for these variables (52).

2.6.2a Measures of Depression

Measurements of hypertension and depression were highly variable. Measures of hypertension were the same as those discussed previously in the studies of hypertension and anxiety. Depression was measured by a number of scales including the Beck Depression Inventory (BDI) (30, 39), the 20-item Center for Epidemiological Studies-Depression (CES-D) scale (13, 27, 42-44), the General Well-Being Depression (GWB-D) subscale (43), the 18-item Alameda County Study depression scale (28)and structured interviews to obtain *DSM* Depression diagnosis (19, 31, 51, 52).

In the two studies that used the BDI, one found a positive association and one found no association (30, 39). All four studies that used the CES-D scale found no association (13, 42-44). Among the four studies that used *DSM*-defined depression, one measured blood pressure, one used measured and self-reported hypertension, and two used self-reported hypertension. A cross-sectional study in Brazil measured hypertension and found no crude or multivariate adjusted association between *DSM* depressive disorders and hypertension (51). Cross-sectional studies in Brazil and New Zealand found no association between self-reported hypertension and depression (19, 31). Most interesting are the findings of an American cross-sectional study where the association between depression and hypertension was significant in self-reported hypertension different associations with self-reported hypertension and measured hypertension (OR=3.95, CI= 1.51-10.35) but not with measured hypertension (OR=0.85). This was after adjusting for sociodemographic factors, stressors, and lifestyle factors (52). Adjustment for stress led to a substantial decrease in the odds ratio between depressive symptoms and hypertension but did not fully nullify the association. Therefore, stressful life events are an important confounder or mediator in the hypertension-depression relationship. Furthermore, the discrepancy in results suggests there may be important

differences between self-reported and measured hypertension and the association with depression.

2.6.3 Evidence of an association between hypertension and comorbid anxiety-depression

Most of the literature examines the relationship between blood pressure and either depression or anxiety alone. Few studies examine both depression and anxiety together despite their symptoms and disorders often co-occurring (42).

Jonas et al (17) cites evidence that comorbid anxiety-depression is more prevalent in women than in men, and in black women than in white women. Furthermore, after controlling for age, race, sex, baseline blood pressure, education, smoking, alcohol, and BMI those with comorbid anxiety-depression had an increased relative risk of self-reported hypertension, incident hypertension, and treated hypertension. However, the results did not examine the differences between those with comorbid depression-anxiety, and those with non comorbid depression and non comorbid anxiety. The relationship between comorbid anxiety-depression and chronic physical conditions was examined in the data from 17 countries that completed World Mental Health surveys (16). Those with non-comorbid depressive disorder, non-comorbid anxiety disorder, and comorbid depression-anxiety were all more likely to have hypertension compared to persons with neither a depressive nor an anxiety disorder (OR=1.5, 1.7, 1.8, respectively). Subsequent analysis showed no significant difference in the strength of the comorbid anxiety-depression association with hypertension and the strength of the non-comorbid anxiety or depression and hypertension association (OR=1.0, 95% CI: 0.9-1.2).

2.7 Summary of the Evidence

Globally there is a high burden associated with hypertension and mental disorders. In South Africa, there is a strong and increasing burden associated with hypertension and very limited evidence available on the prevalence and impact of mental disorders. There is mixed evidence on the association between hypertension and anxiety disorders, with conflicting results from studies using the same design, and using the same measurements. Most research finds a crude association, but adjustment for demographic, socioeconomic, and lifestyle factors often attenuate the relationship. The evidence of the association between hypertension and depressive disorders is less robust. Furthermore, it appears there may be a difference in the association between depressive disorders and those with measured hypertension compared to self-reported hypertension diagnosis. A relative paucity of evidence exists on the associations with comorbid anxiety-depression with only two studies examining comorbid anxiety-depression and hypertension.

In general, the measure of mental health is based on symptoms of anxiety or depression as opposed to *DSM* diagnosis of mental disorders. Furthermore, inconsistent results for the associations between hypertension and anxiety and hypertension and depression may be a result of failure to control for comorbid anxiety-depression (42) or known confounders. Tables in Appendixes A-C summarize the individual studies reporting on the association between hypertension and anxiety disorders, depressive disorders, and comorbid anxiety-depression.

2.8 Potential confounding variables in the Hypertension-Anxiety & Hypertension-Depression association

Adjustment for confounders is necessary to ascertain the true association between hypertension and common mental disorders. A list of potential confounders is described below, with both the evidence and the nature of the association summarized.

2.8.1 Demographic characteristics

Age is commonly adjusted for as the association between hypertension and age has been consistently demonstrated. Systolic and diastolic blood pressure rises progressively between childhood and older age (11). However, in non-westernized societies, an increase in age-related blood pressure is observed only after adopting a western lifestyle. It is therefore said that the association must be in environmental changes and not genetic influences; in conjunction with the important role that diet plays (11). Increasing age may also increase risk of mental disorders.

While the overall prevalence of mental disorders is the same in men and women, women have a greater prevalence of anxiety and depressive disorders (7). A review of agoraphobia and panic disorders in Europe concluded the prevalence to be twice as high in women (53). In the papers reviewed, results from Chinese and American studies found female sex to be an independent predictor of anxiety disorders (40, 43).

Hypertension prevalence is not uniform across race groups (27, 54, 55). In African-Americans, the age-adjusted relative risk for hypertension comparing blacks with whites was 2.33 in women and 1.95 in men (55). In the South African context, socioeconomic status has historically paralleled racial groups as a result of apartheid. Interpretations of race are highly

context-specific, and must also be considered in terms of applicability and adjustment for other factors such as socioeconomic status.

None of the studies reviewed looked at marital status or urbanicity (rural/urban) as potential confounders. However, depression is associated with less interpersonal relationships and residing in an urban as opposed to an rural area (15).

2.8.2 Socioeconomic status (SES)

The World Heath Report 2001 cites four cross-national studies (Brazil, Chile, India, Zimbabwe) where data show that common mental disorders are twice as frequent among the poor as among the rich (7). SES affected one year and lifetime prevalence of mental disorders, as well as the course of the disorder (56). Resultantly, it can be hypothesized that comorbidity will be greater in socioeconomically disadvantaged individuals where adequate treatment was unavailable and therefore further conditions developed.

Lower educational attainment was an independent risk factor for incidence of hypertension in the United States (55). Of the four studies reviewed that adjusted for education, none found it to be an independent predictor of hypertension (13, 27, 28, 30).

Only the Almeda County Study adjusted for employment, and it was not an independent risk factor overall. However, women who worked in blue collar jobs were more likely to have incidence hypertension compared to those in white collar jobs (OR=1.3) (28).

2.8.3 Lifestyle Factors

Smoking was an independent risk factor for hypertension in some studies (28) and not in other studies (27, 30). Interestingly, an American study found former smoking to be an independent predictor of self-reported hypertension, but not of measured hypertension (52).

A paper from Zimbabwe found current smoking to be an independent risk factor for hypertension among White students (p-value<0.001) but not Black students (p-value=0.53) (47). Alcohol consumption was an independent predictor among those with measured hypertension in three studies (44, 47, 52) but not significant in four other studies (13, 27, 28, 30).

2.8.4 Comorbidities

Hypertension commonly co-exists with other chronic physical conditions. Similarly, anxiety and depressive disorders have high level of co-occurrence with other mental disorders. Therefore, to discover the true association between hypertension and anxiety and depressive disorders, it is necessary to adjust for the comorbidities.

Hypertension is one of the most common risk factor factors for chronic disease, and one of the five conditions that make up metabolic syndrome. Metabolic syndrome is a constellation of interrelated risk factors of metabolic origin that promote cardiovascular disease and diagnosis requires three or more of the following: obesity, low concentration of high-density lipoprotein cholesterol, blood pressure above 130/85mm Hg, elevated triglycerides and elevated fasting glucose (57, 58). The chronic physical conditions associated with hypertension include: coronary heart disease, ischemic heart disease, stroke, myocardial infarction (MI), heart failure, type 2 diabetes, arthrosclerosis kidney disease, and end-stage renal disease (58). Few of the studies investigating the relationship between hypertension and mental health adjusted for other chronic physical conditions. One study adjusts only for glucose intolerance (46), while two other adjust for three and five other conditions, respectively. A strong positive association between measured and treated hypertension and anxiety as well as hypertension and depression persisted after adjustment for history of diabetes, stroke and coronary heart disease (29). Similarly, the positive association between hypertension and anxiety persisted

with adjusted for myocardial infarction, angina, stroke, hypercholesterolemia and type 2 diabetes (42). However, hypertension is associated with many chronic physical conditions, and therefore previous adjustment may have been insufficient.

Similar to the clustering of chronic physical conditions, there is significant comorbidity of anxiety and depression. Prior research has rarely controlled for mental comorbidity. In one study, the association between hypertension and anxiety was insignificant after adjustment for sex and substance use disorder, but after adjusting for depression became significant (23). It is therefore unclear if the previously found associations between anxiety and hypertension are due to comorbid depression, or conversely, the associations between hypertension and depression are due to comorbid anxiety disorders. There is also consistent evidence of significant comorbidity with the presence of mental disorders and substance abuse and dependence (7, 59). Therefore, to rule out substance abuse disorders as a confounder, it must be included in multi-variate analysis.

2.8.5 Traumatic Life Events

Only one study has examined the impact of traumatic events on hypertension (52). A cross-sectional study in Harlem New York found that after controlling for age, sex and other lifestyle factors, all five stressor variables were significantly associated with measured hypertension. However, in the model predicting self-reported hypertension, only current employment at the 10% level of significance was associated with hypertension. Therefore, the stress from traumatic life events may be a confounder in the relationship between depressive symptoms and hypertension. Traumatic life events are included as they are of particular interest due to the high levels of trauma in South Africa and their strong association with mental disorders (20).

2.8.6 Summary of potential confounders

Evidence suggests that a number of demographic, socioeconomic and lifestyle factors may be confounders in the relationship between hypertension and common mental disorders. Sufficient adjustment for age, sex, race, SES, as well as smoking and alcohol use and comorbid chronic physical conditions and mental disorders is therefore necessary to find the true relationship between hypertension and anxiety, and hypertension and depression.

3 METHODS

3.1 Background

The South African Stress and Health (SASH) study is a large cross-sectional survey of mental health of the South African population. The study is affiliated with the World Health Organization (WHO) World Mental Health (WMH) Survey Initiative (60). In response to the Global Burden of Disease study which highlighted the prevalence and burden of mental health worldwide, the World Health Organization initiated the WMH Surveys to obtain accurate information on the prevalence and correlates of mental, substance, and behavioural disorders in all regions of the world (36, 61). The Initiative conducted surveys in 26 countries representing all WHO regions. Its rationale and the SASH rationale and design have been described in detail previously (60, 62).

Ethical approval for SASH including all survey protocol recruitment, consent and field procedures, was approved by the Research Ethics Committee at the University of Stellenbosch, the Human Subjects Committees of the University of Michigan, Harvard Medical School, and by a single project assurance of compliance from the Medical University of South Africa that was approved by the National Institute of Mental Health. Ethical approval for the analysis of SASH for this thesis was approved by the Research Ethics Committee of the Heath Sciences Faculty at the University of Cape Town (Rec Ref 248/2007).

3.2 Survey Population

SASH sampling and data collection were conducted between January 2002 and June 2004. The survey population included all resident South African adults (18 years and older) who lived in households and hostels during the field period of the study. The survey population included individuals of all race and ethnic backgrounds. The SASH survey population did not

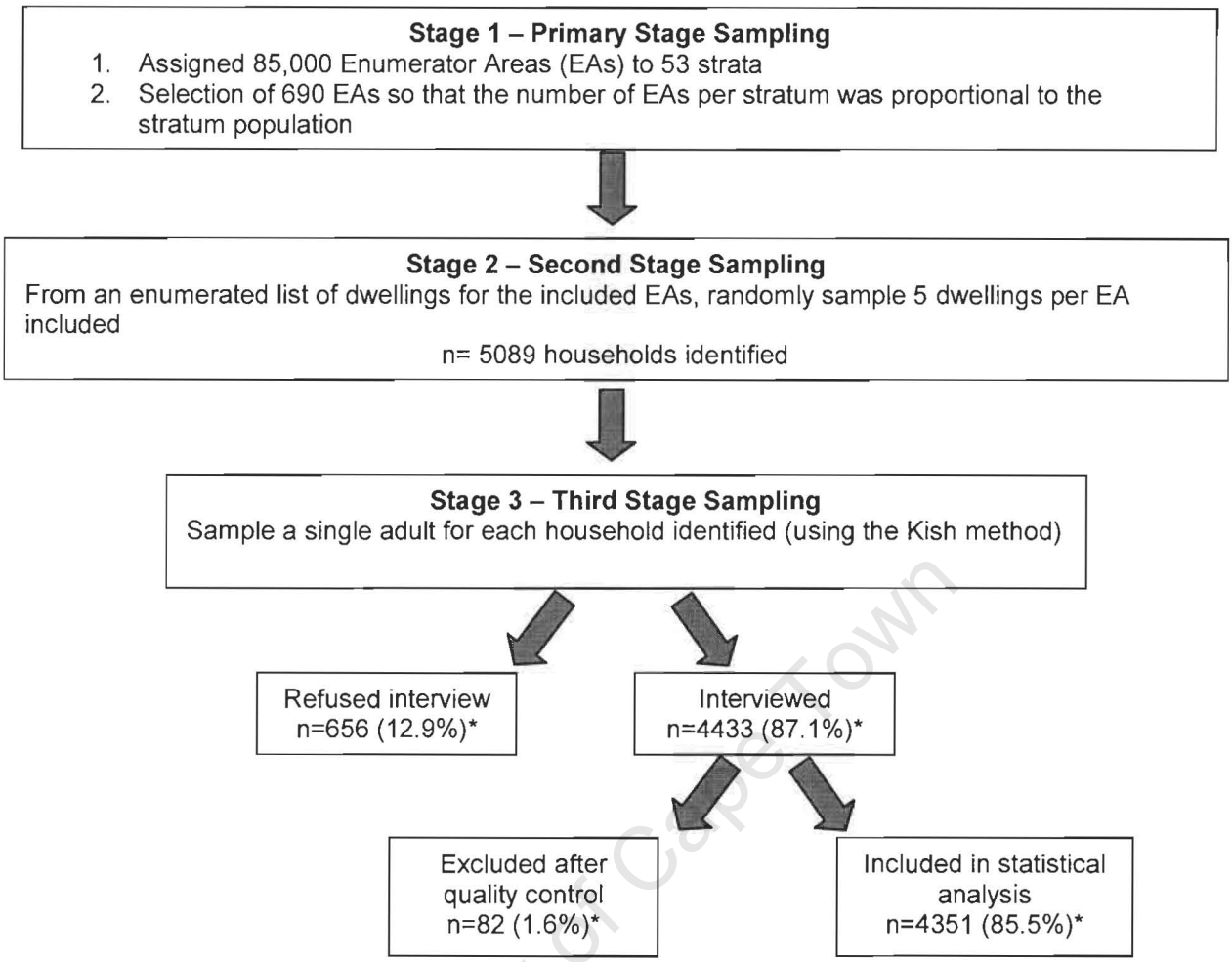
dwelling units was selected from each EA to be included in the study population and was subsequently contacted for the interview. A total of 5089 households were selected for SASH interviews.

3.3.3 Third Stage Sampling

Within each selected dwelling unit, a single adult respondent was selected for SASH interviewing using the Kish procedure for objective selection (64). Fieldworkers made up to three attempts to contact the selected participants. If the selected respondent or household refused to be interviewed for SASH, a replacement was randomly selected from the enumerative listing of that EA. An appropriate adjustment for this type of non-response and reselection was entered into the statistical analysis. The survey had a high initial response rate of 87% and therefore, it is unlikely that the resampling had a serious impact on the representatitiveness in the data. This procedure for replacement of the noncompliant individuals/households was a departure from the selection protocol of the WHO World Mental Health Initiative data collection recommendations.

The response rate was 87.1%. Quality control criteria excluded eliminated 83 people from the analysis. A total of 4351 field interviews were retained and used for the subsequent analysis. Person-level weights that incorporate sample selection, non-response and post-stratification factors were generated to adjust for the complex survey design.

Figure 1: Sampling Process



*Percentages are calculated as the percentage of households identified for interviewing (denominator=5089)

3.4 Measurement

The measurement used in the SASH was a questionnaire; the World Mental Health pencil and paper (PAPI) version of the WHO Composite International Diagnostic Interview Version 3.0 (CIDI-3.0) to assess mental disorders (65). The WMH-CIDI 3.0 is a comprehensive, fully-structured interview that assesses mental disorders according to the definitions and criteria of both *DSM-IV* and WHO International Classification of Diseases-Version 10 (ICD-10) (66). It is intended for epidemiological and cross-cultural studies and allows the investigator to measure prevalence, severity and burden of mental disorders. Lifetime and 12-month versions of anxiety disorders, mood disorders, and substance disorders were obtained. Furthermore,

information on demographics, socioeconomics, other chronic physical conditions and traumatic life events was collected.

DSM-IV is the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders, published in 2000. It is the official nomenclature used in the United States by psychiatrists and other mental health professionals to assess mental disorders (15). The ICD-10 is the diagnostic criteria of mental disorders from the tenth edition of the WHO International Statistical Classification of Diseases and Related Health Problems. While there are differences in the diagnoses of disorders between the two systems, they are coded using the same diagnostic code numbers to ensure standardized reporting. For the purposes of this research study, the *DSM-IV* diagnoses were used to define mental disorders.

Interviews were conducted in the homes of the selected participants by trained field interviewers. The interviewers were trained in psychiatric interviewing and conducted the structured Diagnostic Interview. It was scripted into six of the national languages: English, Afrikaans, Zulu, Xhosa, Northern Sotho, and Tswana. Interviews lasted approximately 3 hours and were sometimes conducted over multiple visits of the interviewer.

3.5 Variables

3.5.1 Hypertension

Hypertension was assessed as self-reported lifetime diagnosis in the section on *Chronic conditions* in the questionnaire. Participants responded to the following question: "Did a doctor or other health professional ever tell you that you had any of the following illnesses: high blood pressure". Observations that were missing or coded as "refused" or "don't know" were coded as not having a hypertension diagnosis (total number of missing=60). From this question, a binary yes/no variable for hypertension was created.

In addition, a four-level categorical variable combining hypertension and other chronic physical conditions was created. This variable was divided into none (no chronic physical condition), hypertension only, hypertension plus another chronic physical condition, and other chronic physical condition only. The chronic physical conditions included in this variable are listed in the chronic physical conditions section of other variables below (Section 3.5.5*)*.

3.5.2 Mental Health

Lifetime and 12-month *DSM-IV* diagnosis of the following anxiety disorders were included in this analysis: (i) panic disorder without agoraphobia, (ii) generalized anxiety disorder (GAD), (iii) social phobia, (iv) agoraphobia without panic disorder, and (v) posttraumatic stress disorder (PTSD). The *DSM-IV* criteria for each of these disorders are described in the Appendixes D-H.

Panic disorder is the recurrence of panic attacks which are not due to the direct physiological effects of a substance or general medical condition and are not accounted for by another mental disorder. A panic attack must be followed by at least of month of concern regarding the attack or a change in behaviour.

Generalized anxiety disorder can be thought of as persons who seem to be anxious about almost everything (15). It is defined as having excessive anxiety and worry occurring more days than not for at least six months. The anxiety and worry is associated with somatic symptoms including restlessness, fatigue, and irritability that cause significant impairment in important areas of functioning.

Social phobia (also called social anxiety disorder) is an excessive fear of humiliation or embarrassment in one or more social and performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others. The person acknowledges the

fear to be excessive. Exposure to such a social situation provokes anxiety and the person avoids such situations even though it disrupts their normal routine.

Agoraphobia without panic disorder is anxiety about being in places or situations from which escape might be difficult, and situations are avoided or endured with panic-like symptoms. It is thought to be the most disabling of phobias.

Posttraumatic stress disorder (PTSD) is distress experienced following a traumatic event. It involves avoidance of stimuli associated with the trauma, and the symptoms are persistent (for the duration of more than one month) and disturb important areas of functioning.

The variable of 12-month anxiety disorder was a *DSM-IV* diagnosis in the last 12-months for one or more of the five mental health diagnosis listed above. Similarly, the variable of lifetime anxiety disorder was a *DSM-IV* lifetime diagnosis of one or more of these five conditions.

Lifetime and 12-month *DSM-IV* diagnosis of major and minor depression were assessed. Major depression is defined as the presence of two or more major depressive episodes which are not the result of schizoaffective disorder. Minor depression is used to describe a wide range of disorders and is defined by having a mood disturbance without ever having a major depressive episode. The *DSM-IV* criteria for diagnosis of major and minor depression are outlined in Appendixes I-J.

In addition to variables for 12-month and lifetime anxiety and depressive disorders, variables were created to capture those who had mental comorbidity with both an anxiety disorder and a depressive disorder. Variables for comorbid anxiety-depression were constructed separately using lifetime and 12-month diagnoses.

Substance use disorders were treated as a potential confounder. The variable for substance use disorders included lifetime *DSM-IV* diagnosis of alcohol abuse (with and without depression), alcohol dependence with abuse, drug abuse (with and without depression) and drug dependence with abuse.

Within the dataset, information was also available on the age of onset for the *DSM-IV* mental disorders. This information was used to generate an age of onset for those with anxiety and/or depression. In the case of those with comorbid anxiety-depression, the earliest age of onset was used. This age of onset was then divided into a 4 level categorical variable for time elapsed since the onset of the condition: none (no anxiety or depression), 0-3 years, 4-10 years, and 10 plus years between current age and age of onset.

3.5.3 Demographic characteristics

Participant demographic characteristics, including age, sex, location (rural/urban), race, and marital status were investigated using standard questionnaire items. Age was stratified into four categories: 18-29; 30-39; 40-49; 50 or older. Race consisted of four standard categories: Black; White; Indian/Asian; Coloured. Marital status was categorized as: married or unmarried.

3.5.4 Socioeconomic status (SES)

SES was investigated using imputed family income, years of participant education, and participant employment. Education was analyzed as categorical variable: None-Grade 7, Grade 8-11, completed high school, and post high school. Categories of family income (in Rands (R)) included: none; R1-5,000; R5,001-25,000; R25,001-100,000; and R100,000 or more. Work status was a dichotomous variable representing currently employed or unemployed.

Because these traditional markers of socioeconomic status may not adequately capture variation in socioeconomic position in developing-country settings where there is a substantial informal economy and resource sharing is common, an asset index was generated based on 17 items reflecting individual and household wealth. This was based on: household ownership of appliances (refrigerator/freezer; vacuum/floor cleaner; television; video cassette recorder; radio; microwave; and washing machine), other household resources (telephone; running water in the home; kitchen sink; flush toilet; automobile; domestic servant; and stove/hotplate) and financial activities which participants engaged in (shopping at a supermarket; using financial services such as a bank account or credit card; and having an account at a retail store). This index has been shown to have excellent reliability (Cronbach's alpha, 0.92). These measures of asset ownership were used to construct an aggregate asset score, which was categorized into categories for 0-5 6-12 and 13-17 assets.

An aggregate measure of socioeconomic status was created for use in the multivariate modelling. Individual income, education and asset index values were standardized, and then summed to create an aggregate measure of SES. This measure was divided into quartiles from lowest to highest SES.

3.5.5 Chronic physical conditions

A variable for chronic physical conditions (other than hypertension) was created. The variable included self-reported conditions in the following 12-months and lifetime diagnosis from a health professional. The following questions were summarized in this variable:

"Have you had any of the following in the past 12 months:

1) arthritis or rheumatism,
2) chronic back or neck problems,
3) any other chronic pain,
4) a stroke,
5) a heart attack"

"Did a doctor or other health professional ever tell you that you had any of the following illnesses:

6) heart disease
7) asthma,
8) any other chronic lung disease like COPD (chronic obstructive pulmonary disease) or emphysema,
9) diabetes or high blood sugar,
10) an ulcer in your stomach or intestine,
11) thyroid disease,
12) a neurological problem, like multiple sclerosis, Parkinson's, or seizures,
13) epilepsy or seizures,
14) cancer".

Data that were missing or coded as "refused" or "don't know" was coded as not having the chronic physical condition.

In addition, chronic physical conditions were divided into vascular and non-vascular. Vascular conditions included the questions on stroke, heart attack, heart disease, and diabetes and non-vascular included the other ten chronic physical conditions.

3.5.6 Alcohol

Two variables were created to describe alcohol use based on lifetime use and current use. Lifetime alcohol use was created from the question: "Think about the years in your life when you drank most. During those years, how often did you usually have at least one drink". For those people who answered "No" to the question: "Was there ever a year in your life when you drank more than you did in the past 12 months?, their drinking behaviour for the last 12-months was used for their lifetime use measure. Current alcohol use was created from the question: "Think about the past 12 months. In the past 12 months, how often did you usually have at least one drink". For both lifetime and current use, alcohol use was analysed a categorical variable of more than once a week, once a week to once a month, and less than once a month. Data that were missing or coded as "refused" or "don't know" was coded as never using alcohol.

3.5.7 Smoking

Two variables were used to describe smoking behaviour, lifetime smoker and current smoker. Lifetime smokers were defined as those who answered yes to the question: "Have you ever smoked more than 100 cigarettes in your lifetime?" Current smokers were defined as those who answered yes to the question: "Do you currently smoke". Where data was missing or coded as refused or don't know participants were assumed to be non-smokers.

3.5.8 Life Events

Lifetime experience of trauma was measured by 28 items used to screen for posttraumatic stress disorder in the World Mental Health survey, including experiences of war, natural disasters, accidents, illness, loss of loved ones, abuse and crime. Traumatic life events are categorized into separate ordinal variables of none, 1-2, 3-4 and 5 or more traumas. Traumatic life events were treated as a potential confounder and therefore adjusted for in multivariate analysis.

3.6 Response Rates

Overall, the response rates for the questionnaire items included in the analysis were high. For the variables for age, sex, race, marital status, income, and education all participants had responses as these questions were answered more than once in the questionnaire and therefore imputed values were available. Over 95% of the sample completed the questions for anxiety and depressive disorders, chronic physical conditions, traumatic life events, and smoking behaviour. Response rates for alcohol use were low, with approximately 66% of respondents replying to questions on alcohol consumption.

3.7 Analysis

Data were analysed using Stata Version 10.0 (Stata Corporation, College Station, USA). All analyses reported accounted for the complex survey design based on person-level weights that incorporated sample selection, non-response and post-stratification factors. This is with the exception of calculations made for specific anxiety and depressive disorders and prevalence of hypertension (Tables 7 & 8) which is acknowledged below.

3.7.1 Univariate and bivariate analysis

Descriptive statistics using univariate and bivariate methods were generated with continuous variables reporting means and categorical data reporting proportions. The prevalence and proportions of the demographic and socioeconomic variables, as well as other variables (alcohol use, smoking, chronic physical conditions and traumatic life events), were examined among the total sample, and stratified by hypertension, anxiety disorders (lifetime and 12-month), depressive disorders (lifetime and 12-month), and comorbid anxiety-depression (lifetime and 12-month). The odds ratios (OR) and 95% confidence intervals (CI) of anxiety disorders, depressive disorders, and comorbid anxiety-depression by demographics, socioeconomic and other variables were generated with those with no mental disorder (no anxiety or depression) as the reference group. Subsequent analysis also generated odds ratios comparing those with anxiety disorders to those without, those with depressive disorders to those without and those with comorbid anxiety-depression to those without comorbid anxiety-depression. Furthermore, the prevalence, proportions and odds ratios where recalculated for non-comorbid anxiety and non-comorbid depression.

The prevalence of hypertension and other chronic physical conditions in those with mental disorders (anxiety, depression and comorbid anxiety-depression), or the physical-mental comorbidity prevalences, were calculated for both lifetime and 12-month mental disorders.

For each crude association, Pearson's chi-squared test used to compare proportions was calculated with the reference group being those without anxiety or depression. In addition, age adjusted odds ratios, with the reference group being those without anxiety or depression, with 95% confidence intervals and Pearson's chi-squared test for comparison of proportions were calculated for the physical-mental comorbidities. All statistical tests were two-sided at $\alpha=0.05$.

The prevalence of hypertension by each of the anxiety disorders and both major and minor depression was also calculated, with Pearson's chi-squared test was used to compare proportions. These calculations were crude, or unadjusted for the survey sampling design. This was necessary to generated standard errors and confidence intervals because of the small numbers of people with each specific mental disorder.

3.7.2 Multivariate analysis

We developed a series of multiple logistic regression models to assess the independent association between, 1) hypertension and anxiety disorders, 2) hypertension and depressive disorders, and 3) hypertension and comorbid anxiety-depression. For each of the three disorders, separate models for both lifetime and 12-month diagnoses were generated. Furthermore, models for both hypertension as a binary variable (yes/no) and categorical variable including other chronic physical conditions (no chronic physical condition, hypertension only, hypertension and another chronic physical condition, and another chronic physical condition) were built. Model A included demographics, Model B added the aggregate measure of SES, Model C added lifetime smoking and alcohol use, Model D added substance use disorders and Model E also included traumatic lifetime events. All of the final models were rerun restricting to Blacks only. The final models were also rerun stratifying by sex.

A second set of multiple logistic regression models were built to predict hypertension diagnosis and adjust for mental comorbidity, one set including lifetime and the other set including12-month mental disorders. Therefore, hypertension diagnosis was predicted by a four level-categorical variable of mental disorders: none (no anxiety or depression), non-comorbid anxiety, non-comorbid depression, and comorbid anxiety-depression. Model A was the crude association, Model B added demographics, and Model C included demographics and other chronic physical conditions.

3.7.3 Additional analyses

To investigate temporality of the hypertension-anxiety and hypertension-depression association, the prevalence of hypertension by time since diagnosis was calculated. This calculation was also made stratifying for those currently 35 years or younger and those over 35 years of age.

4 RESULTS

4.1 Description of sample

The SASH survey included 4351 individuals with a mean age of 37.0 years. The demographic characteristics and socioeconomic characteristics of the study sample are presented in Table 1. More than half of the sample was 30 years or older (61%) and half of the sample was married (50%). 76% of the sample was Black, 10% Coloured, 10% White and 3% Indian/Asian. Less than a third of the sample was employed (31%) and 74% had completed at least some high school.

Overall, 17% of participants reported being told in their lifetime that they had hypertension (Table 1). Anxiety disorders were common with 16% of the sample having a lifetime anxiety disorder and 8% of the sample having a 12-month anxiety disorder (data not shown). Panic disorder was the most common lifetime anxiety disorder with a prevalence of 12%, followed by agoraphobia at 10%, social phobia at 3%, generalized anxiety disorder at 3%, and PTSD at 2% (data not shown). 12% of the sample had a lifetime depressive disorder and 5% a 12-month depressive disorder. The lifetime prevalence of major depressive disorder was 10% compared to lifetime minor depression with a lifetime prevalence of 2% (data not shown). Of the total sample, the lifetime prevalence of comorbid anxiety-depression was 4% and 12-month prevalence was 1% (data not shown).

More than forty percent of the sample (43%) had at least one chronic physical condition (Table 1). Chronic physical conditions were highly prevalent in the population with 26% reporting chronic back or neck problems, 4% having a heart attack in the last 12-months, and more than 5% reporting a lifetime diagnosis of asthma, diabetes, or an ulcer (Table 2).

Table 1: Description of sample, stratified by hypertension diagnosis

	Total	Hypertension diagnosis	No hypertension diagnosis	p-value
	%	%	%	
N (%)	4351	767 (16.7)	3584 (83.3)	
Demographic Characteristics				
Mean Age	37.0	50.3	34.3	-
Age categories: 18-29	39.1	9.0	45.1	<0.001
30-39	22.1	13.5	23.8	
40-49	18.1	24.2	16.9	
50+	20.7	53.3	14.2	
Sex Male	46.3	28.0	50.0	<0.001
Female	53.7	72.0	50.0	
Race Black	76.2	76.1	76.3	0.271
Coloured	10.4	11.7	10.2	
White	10.0	10.2	9.9	
Indian/Asian	3.4	2.0	3.6	
Currently married	50.1	54.0	47.1	<0.001
Location: Rural	38.4	41.6	37.7	0.074
Urban	61.6	58.5	62.3	
Socioeconomic status				
Education :None	6.8	12.7	5.6	<0.001
Grade 1-7	19.1	33.9	16.2	
Grade 8-11	35.4	32.9	35.9	
Completed high school	23.5	11.4	25.9	
Post-high school education	15.3	9.2	16.5	
Employed	31.0	26.0	32.0	0.020
Household income (mean)	59403.9			
R0	13.7	13.3	13.7	0.244
R1 – 5000	29.5	32.9	28.9	
R5001-25000	15.4	16.7	15.1	
R25000-100000	19.6	17.4	20.1	
R100001+	21.8	19.7	22.3	
Assets owned by household: 0-5	39.3	38.3	39.5	
6-12	37.4	41.0	36.7	
13-17	23.3	20.7	23.8	0.177
SES Quartile – 0	22.5	36.0	19.8	<0.001
1	24.5	22.1	24.9	
2	25.0	20.8	25.9	
3	28.0	21.0	29.4	
Other				
Alcohol: Lifetime – None	77.8	79.1	77.5	0.157
Rare	5.8	7.0	5.5	
Moderate	7.5	5.7	7.9	
Heavy	8.9	8.2	9.1	
Current – None	65.7	71.8	64.5	0.053
Rare	10.2	8.7	10.5	
Moderate	16.8	13.5	17.4	
Heavy	7.3	6.0	7.6	
Smoking				
Lifetime smoker	30.0	26.1	30.8	0.033
Current smoker	23.8	15.9	25.4	<0.001
Chronic physical conditions	42.6	78.5	35.4	<0.001
Vascular	11.2	40.2	5.4	<0.001
Other	39.4	69.9	33.3	<0.001
Traumatic life events				
None	26.6	17.3	28.5	<0.001
1-2	49.9	52.5	49.4	
3-4	10.8	11.9	10.6	
5 or more	12.7	18.3	11.5	

Table 2: Prevalence of specific chronic physical conditions by lifetime mental disorders

	Total Sample	No anxiety or depression	Anxiety or Depression		Anxiety		Depression		Comorbid anxiety-depression	
	% (95% CI)	% (95% CI)	% (95% CI)	p-value	% (95% CI)	p-value	% (95% CI)	p-value	% (95% CI)	p-value
12-month conditions (n)										
Arthritis or rheumatism (453)	10.0 (9.1-11.0)	9.0 (8.0-10.2)	13.5 (11.3-15.9)	0.001	14.4 (11.7-17.7)	0.001	12.3 (9.5-15.9)	0.027	13.8 (9.4-19.9)	0.036
Chronic back or neck problems (1173)	26.1 (24.2-28.2)	23.3 (21.2-25.6)	35.3 (31.7-39.1)	<0.001	35.5 (30.8-40.5)	<0.001	37.4 (32.1-43.1)	<0.001	41.8 (32.5-51.8)	<0.001
Any other chronic pain (533)	12.1 (10.7-13.7)	9.7 (8.2-11.4)	20.2 (16.7-24.2)	<0.001	21.5 (17.1-26.7)	<0.001	20.7 (16.8-25.1)	<0.001	26.2 (18.7-35.4)	<0.001
A stroke (59)	1.3 (0.9-2.8)	1.3 (0.8-2.0)	1.2 (0.6-2.2)	0.842	1.4 (0.7-2.9)	0.838	0.9 (0.3-2.3)	0.495	1.2 (0.2-6.2)	0.916
A heart attack (187)	3.7 (3.0-4.4)	3.1 (2.4-3.9)	5.8 (4.2-7.8)	0.001	7.0 (4.9-9.8)	<0.001	5.2 (3.3-8.1)	0.031	8.8 (5.0-14.8)	<0.001
Lifetime diagnosis (n)										
Heart disease (184)	3.8 (3.3-4.4)	3.1 (2.5-3.8)	6.3 (4.5-8.8)	0.002	7.9 (5.4-11.5)	<0.001	5.7 (3.8-8.4)	0.015	10.6 (6.3-17.1)	<0.001
Asthma (258)	5.8 (4.9-6.7)	4.9 (4.0-6.0)	8.6 (6.6-11.2)	0.002	9.5 (7.0-12.8)	0.001	8.8 (6.1-12.6)	0.009	12.2 (7.3-19.8)	0.003
Hypertension (767)	16.7 (15.4-18.1)	15.1 (13.7-16.7)	21.8 (19.3-24.5)	<0.001	23.2 (19.9-26.8)	<0.001	20.2 (16.4-24.6)	0.011	22.2 (16.8-28.7)	0.010
Lung disease (52)	1.4 (1.0-2.2)	10.8 (6.9-16.8)	2.6 (1.4-4.9)	0.013	2.6 (1.3-5.2)	0.017	2.5 (1.0-6.2)	0.067	2.3 (0.7-7.5)	0.139
Diabetes (233)	5.5 (5.8-6.4)	4.8 (4.0-5.7)	8.0 (6.1-10.5)	0.003	8.6 (6.5-11.1)	0.001	7.4 (5.0-10.7)	0.042	8.1 (5.0-12.8)	0.042
Ulcer (257)	5.5 (4.6-6.4)	4.3 (3.4-5.4)	9.1 (7.3-11.4)	<0.001	9.0 (7.0-11.4)	<0.001	9.1 (6.5-12.7)	0.001	8.5 (4.9-14.3)	0.039
Thyroid disease (61)	1.2 (0.9-1.7)	0.9 (0.6-1.3)	2.4 (1.3-4.3)	0.008	2.4 (1.3-4.3)	0.004	2.1 (0.8-5.4)	0.101	1.9 (0.5-7.0)	0.282
Neurological problem (60)	1.4 (1.0-2.0)	1.1 (0.7-1.7)	2.5 (1.5-4.0)	0.010	2.8 (1.7-4.6)	0.005	2.1 (1.0-4.4)	0.106	2.6 (0.9-7.5)	0.137
Epilepsy/Seizure (46)	0.9 (0.6-1.3)	0.6 (0.4-1.0)	1.8 (1.1-3.1)	0.004	2.7 (1.6-4.5)	<0.001	0.7 (0.3-1.7)	0.718	1.9 (0.8-4.5)	0.013
Cancer (33)	0.8 (0.5-1.3)	0.7 (0.4-1.3)	1.1 (0.6-2.3)	0.370	1.4 (0.6-2.1)	0.240	1.0 (0.4-2.2)	0.622	1.6 (0.6-4.3)	0.269

Example: A total of 435 people equalling 10% (95% CI=9.1-11.0) of those in the study reported having arthritis or rheumatism in the past 12-months. Of those with a lifetime anxiety disorder, 14.4% reported having arthritis or rheumatism. People with a lifetime anxiety disorder reported significantly more arthritis or rheumatism compared to those with a lifetime anxiety or depressive disorder (p-value=0.001).

* Reference group: No lifetime anxiety or depressive disorder

4.2 Bivariate Associations

4.2.1 Bivariate associations with hypertension diagnosis

Strong crude associations were found between hypertension diagnosis and age, sex, marriage, education, employment status, smoking (current and lifetime), chronic physical conditions, and traumatic life events (Table 1). Hypertension diagnosis was far more common in women than men (Figure 2), and in those who were married. Among measures of socioeconomic status, those with a hypertension diagnosis were less educated and more likely to be unemployed. The aggregate measure of SES was strongly associated with hypertension; those with a hypertension diagnosis had a lower SES than those without a hypertension diagnosis. There was high physical comorbidity, with 79% of those with a hypertension diagnosis reported another chronic physical condition (Figure 3).

Figure 2: Prevalence of hypertension diagnosis & chronic physical conditions by age and sex

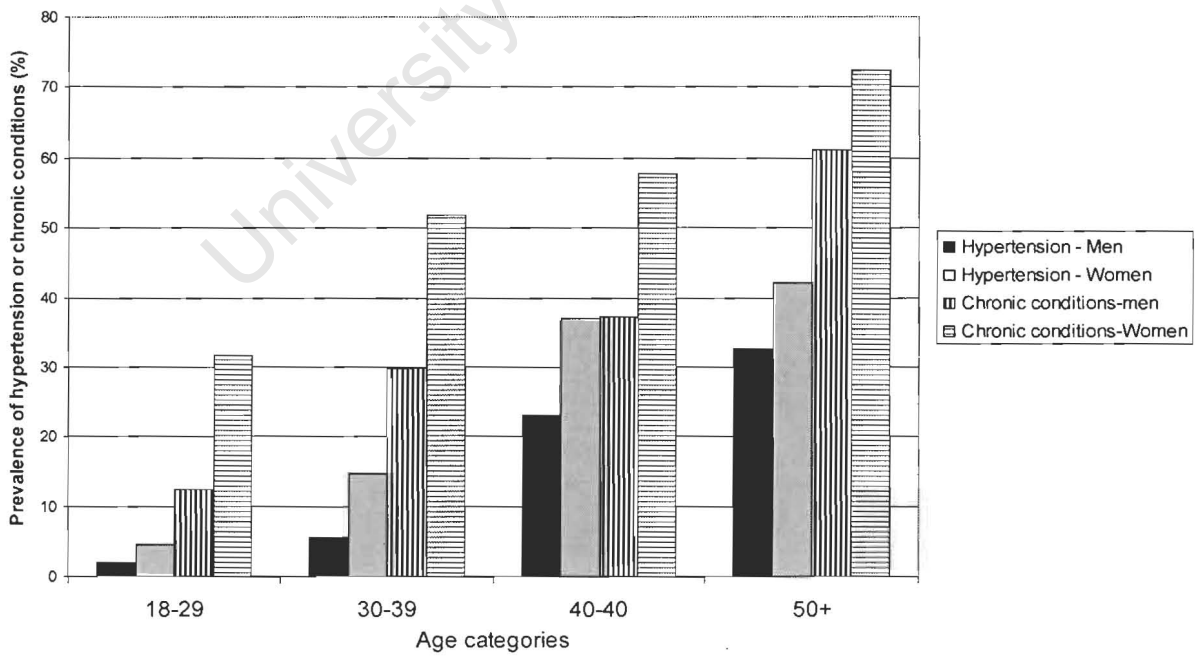
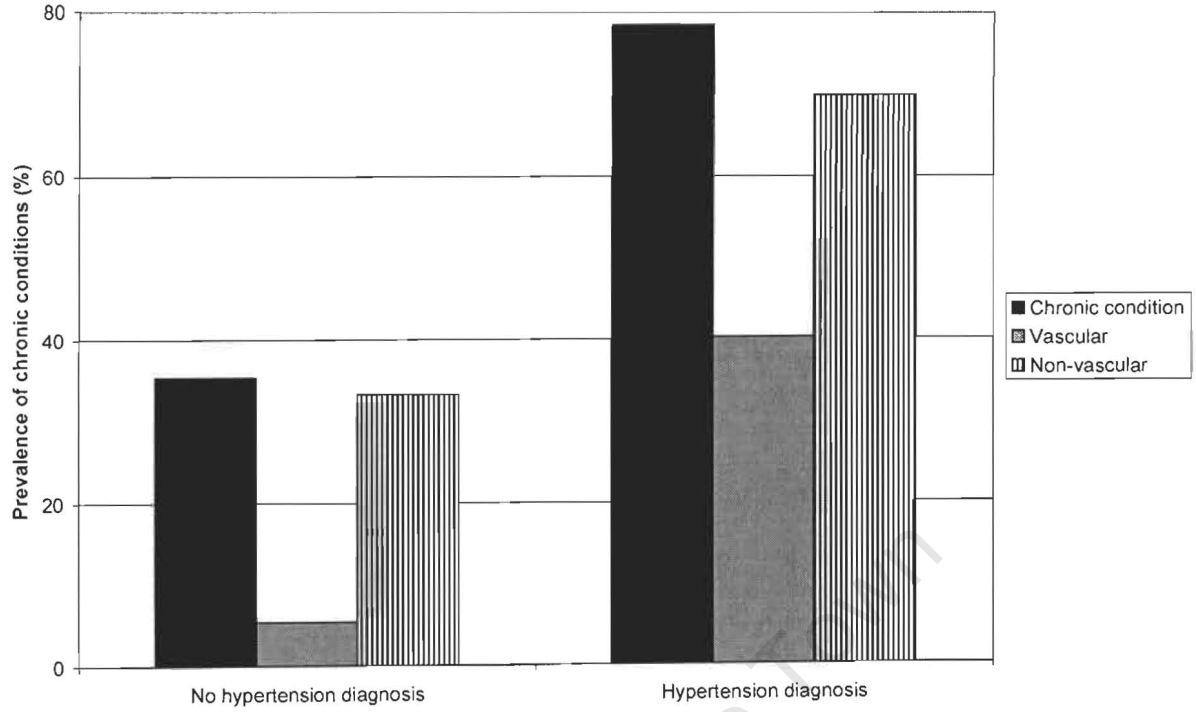


Figure 3: Prevalence of chronic physical conditions (vascular and non-vascular) by hypertension diagnosis



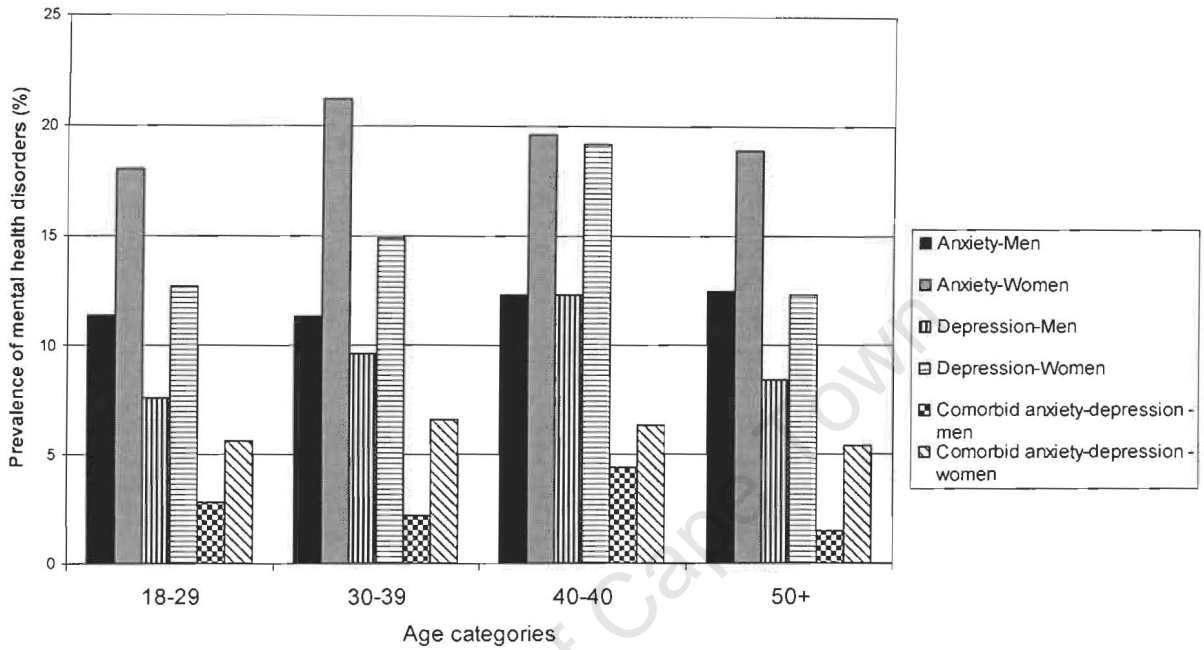
4.2.2 Bivariate associations with anxiety disorders

4.2.2a Bivariate associations with lifetime anxiety disorders

Lifetime anxiety disorders showed a strong crude association with sex, location, alcohol consumption, chronic physical conditions, and traumatic life events (Table 3). Women were 1.86 times more likely to have a lifetime anxiety disorder compared to men (Figure 4). Living in an urban area was also strongly associated with having a lifetime anxiety disorder compared to living in an urban area. Those with an anxiety disorder were twice as likely to have a chronic physical condition, both vascular and non-vascular, compared to those without lifetime anxiety or depression. Those with a lifetime anxiety disorder were 1.96 times more likely to have one or two traumatic life events, 2.48 times more likely to have three or four traumatic life events, and 3.86 times more likely to have five or more traumatic life events compared to those with neither lifetime anxiety disorder nor depression (Table 3). When the reference group was those without an anxiety disorder (as opposed to those with an anxiety or depressive disorder), there was no substantive differences in the odds ratios (data not shown).

Furthermore, when analysis was done restricting to those with non-comorbid anxiety only, the prevalences and associations were not notably different (data not shown).

Figure 4: Prevalence of lifetime anxiety, depression, and comorbid anxiety-depression by age and sex



4.2.2b Bivariate associations with 12-month anxiety disorders

Table 4 presents crude associations with 12-month anxiety disorders. The associations for 12-month anxiety disorder were largely the same as those for lifetime anxiety disorder. However, living in an urban area was not associated and no socioeconomic status variables were associated with 12-month anxiety disorders. The associations between chronic physical conditions and anxiety disorders persisted; those with a 12-month anxiety disorder were more than twice as likely to have a chronic physical condition, both vascular and non-vascular, compared to those without 12-month anxiety or depression. Again, the odds of 12-month anxiety disorder increased as the number of traumatic life events experienced increased.

4.2.2c Bivariate associations between anxiety disorders and hypertension diagnosis

Those with lifetime anxiety disorders were 1.69 times more likely to have a hypertension diagnosis, compared to those without a lifetime anxiety disorder or depressive disorder (Table 3). Those with 12-month anxiety disorders were also more likely to have a hypertension diagnosis (Table 4). Table 5 shows the prevalence of hypertension diagnosis by each anxiety disorder, as well as the crude odds ratio, and an odds ratio adjusted for demographics. Lifetime and 12-month panic disorder without agoraphobia, lifetime GAD, lifetime agoraphobia without panic disorder, lifetime PTSD and 12-month social phobia were all associated with an increased prevalence of hypertension diagnosis.

Table 3: Description of sample by Lifetime *DSM-IV* Anxiety & Depression

	No depression or anxiety	Anxiety	OR (95% CI)	Depression	OR (95% CI)	Comorbid anxiety-depression	OR (95% CI)
	%	%		%		%	
N	3319	699		526		193	
Demographic Characteristics							
Mean Age	36.7	37.6		37.7		36.5	
Age categories: 18-29	40.5	36.4	1.0	33.4	1.0	37.1	1.0
30-39	21.6	23.6	1.2 (0.9-1.6)	23.4	1.3 (1.0-1.7)	23.2	1.2 (0.8-1.8)
40-49	17.2	18.9	1.2 (0.9-1.7)	24.8	1.7 (1.3-2.3)	22.4	1.4 (0.9-2.2)
50+	20.8	21.2	1.1 (0.8-1.6)	18.5	1.1 (0.8-1.4)	17.2	0.9 (0.6-1.4)
Sex Male	49.5	34.5	1.0	35.0	1.0	28.3	1.0
Female	50.5	65.5	1.9 (1.5-2.3)	65.0	1.8 (1.4-2.4)	71.7	2.5 (1.5-4.2)
Race Black	76.0	79.7	1.0	73.9	1.0	77.9	1.0
Coloured	10.3	10.4	1.0 (0.7-1.4)	11.2	1.1 (0.8-1.6)	10.1	1.0 (0.6-1.6)
White	10.4	7.5	0.7 (0.2-1.5)	10.0	1.0 (0.5-2.1)	8.7	0.8 (0.3-2.4)
Indian/Asian	3.3	2.4	0.7 (0.4-1.3)	5.0	1.6 (0.9-2.7)	3.3	1.0 (0.5-1.8)
Currently married	49.9	49.2	1.0 (0.8-1.2)	51.1	1.0 (0.8-1.3)	45.9	0.9 (0.6-1.1)
Location Rural	39.2	33.4	1.0	35.0	1.0	25.4	1.0
Urban	60.8	66.6	1.3 (1.0-1.6)	65.0	1.2 (0.9-1.5)	74.6	1.9 (1.3-2.8)
Socioeconomic status							
Education: None	6.8	7.3	1.0	5.2	1.0	4.5	1.0
Grade 1-7	18.1	19.1	1.0 (0.6-1.6)	27.5	2.0 (1.4-3.0)	23.9	2.0 (0.8-4.9)
Grade 8-11	35.9	35.4	0.9 (0.6-1.4)	33.0	1.2 (0.8-1.8)	38.9	1.6 (0.7-3.8)
Completed high school	23.6	24.0	0.9 (0.6-1.5)	21.0	1.2 (0.8-1.8)	20.9	1.3 (0.5-3.3)
Post-high school education	15.6	14.2	0.8 (0.5-1.5)	13.4	1.1 (0.6-2.0)	11.8	1.1 (0.4-3.5)
Employed	31.3	27.3	0.8 (0.7-1.0)	33.6	1.1 (0.8-1.5)	29.9	0.9 (0.5-1.6)
Household income (mean)	59346.9	62010.8		56161.7		59022.7	
R0	14.3	11.5	1.0	12.2	1.0	12.6	1.0
R1 – 5000	28.5	32.3	1.4 (1.0-1.9)	34.6	1.4 (0.9-2.3)	34.0	1.4 (0.7-2.5)
R5001-25000	15.6	14.9	1.2 (0.8-1.8)	14.5	1.1 (0.7-1.8)	15.6	1.1 (0.6-2.0)
R25000-100000	19.3	21.9	1.4 (1.0-2.1)	18.1	1.1 (0.7-1.8)	18.2	1.1 (0.5-2.1)
R100001+	22.4	19.5	1.1 (0.8-1.6)	20.7	1.1 (0.7-1.7)	19.5	1.0 (0.5-1.8)

Table 3 (continued)

Assets owned by household: 0-5	39.9	36.9	1.0	35.6	1.0	30.7	1.0
6-12	36.8	42.7	1.3 (1.0-1.5)	38.4	1.2 (1.0-1.4)	48.0	1.7 (1.2-2.4)
13-17	23.3	20.4	0.9 (0.7-1.3)	26.0	1.2 (0.9-1.8)	21.3	1.2 (0.6-2.2)
SES Quartiles: 0	22.0	23.2	1.0	24.9	1.0	22.6	1.0
1	25.5	22.5	0.8 (0.7-1.1)	19.8	0.7 (0.5-0.9)	21.9	0.8 (0.5-1.3)
2	24.7	26.7	1.0 (0.8-1.4)	25.3	0.9 (0.7-1.2)	25.1	1.0 (0.6-1.5)
3	27.9	27.6	0.9 (0.7-1.3)	30.1	1.0 (0.7-1.4)	30.3	1.1 (0.6-2.0)
Other							
Hypertension diagnosis	15.1	23.2	1.7 (1.3-2.1)	20.2	1.4 (1.1-1.8)	22.2	1.6 (1.1-2.3)
Alcohol: Lifetime – None	80.4	68.9	1.0	66.5	1.0	61.6	1.0
Rare	5.1	7.9	1.8 (1.2-2.8)	9.3	2.2 (15-3.2)	11.6	2.9 (1.4-6.0)
Moderate	6.9	8.2	1.4 (1.0-2.0)	12.7	2.2 (1.6-3.2)	12.0	2.3 (1.3-4.0)
Heavy	7.6	15.0	2.3 (1.6-3.3)	11.5	1.8 (1.2-2.7)	14.8	2.5 (1.4-4.5)
Current – None	67.7	59.7	1.0	58.6	1.0	58.1	1.0
Rare	8.6	13.8	1.8 (1.3-2.6)	17.9	2.4 (1.7-3.3)	17.2	2.3 (1.3-4.3)
Moderate	16.3	18.7	1.3 (1.0-1.7)	17.8	1.3 (0.9-1.7)	18.9	1.3 (0.8-2.2)
Heavy	7.4	7.8	1.2 (0.7-1.9)	5.7	0.9 (0.5-1.6)	5.8	0.9 (0.3-2.4)
Smoking- Lifetime smoker	28.9	31.4	1.1 (0.9-1.4)	36.8	1.4 (1.1-1.9)	32.9	1.2 (0.8-1.8)
Current smoker	23.3	23.4	1.0 (0.8-1.2)	28.9	1.3 (1.0-1.8)	28.0	1.3 (0.9-1.9)
Other chronic physical condition	38.7	55.4	2.0 (1.6-2.4)	56.6	2.1 (1.6-2.6)	58.9	2.3 (1.6-3.2)
Vascular	9.7	17.9	2.0 (1.5-2.8)	15.2	1.7 (1.2-2.4)	20.6	2.4 (1.6-3.7)
Other	35.7	52.5	2.0 (1.6-2.4)	52.1	2.0 (1.6-2.4)	55.0	2.2 (1.6-3.0)
Traumatic life events							
None	30.2	15.8	1.0	12.0	1.0	10.9	1.0
1-2	49.5	50.5	2.0 (1.4-2.7)	49.9	2.5 (1.8-3.5)	43.4	2.4 (1.5-4.1)
3-4	10.0	12.9	2.5 (1.7-3.6)	15.8	4.0 (2.6-6.0)	17.8	4.9 (2.7-9.0)
5 or more	10.4	20.9	3.9 (2.7-5.5)	22.3	5.4 (3.6-8.1)	27.9	7.5 (4.1-13.5)

* Reference group: No lifetime depression or anxiety disorder

Table 4: Description of sample by 12-month *DSM-IV* Anxiety & Depression

	No depression or anxiety	Anxiety	OR (95% CI)	Depression	OR (95% CI)	Comorbid anxiety-depression	OR (95% CI)
	%	%		%		%	
N	3794	375		249		67	
Demographic Characteristics							
Mean Age	36.8	38.4		37.6		39.5	
Age categories: 18-29	39.8	33.3	1.0	32.2	1.0	22.9	1.0
30-39	21.9	23.2	1.3 (1.0-1.7)	24.4	1.4 (0.9-2.1)	30.8	2.4 (1.0-6.0)
40-49	17.6	21.2	1.4 (1.0-2.1)	23.3	1.6 (1.1-2.5)	20.9	2.1 (1.0-4.2)
50+	20.7	22.3	1.3 (0.8-2.0)	20.2	1.2 (0.8-1.8)	25.4	2.1(1.0-4.5)
Sex Male	48.4	30.1	1.0	29.2	1.0	11.3	1.0
Female	51.7	69.9	2.2 (1.6-2.9)	70.8	2.3 (1.6-3.2)	88.7	7.4 (3.4-16.0)
Race Black	76.2	79.9	1.0	71.8	1.0	79.8	1.0
Coloured	10.1	11.5	1.1 (0.7-1.7)	13.4	1.4 (0.9-2.1)	9.7	0.9 (0.3-2.4)
White	10.4	6.5	0.6 (0.2-1.6)	7.6	0.8 (0.3-2.1)	7.7	0.7 (0.1-5.9)
Indian/Asian	3.2	2.1	0.6 (0.3-1.3)	7.2	2.4 (1.1-5.0)	2.8	0.8 (0.2-3.1)
Currently married	50.1	48.6	0.9 (0.7-1.2)	53.1	1.1 (0.9-1.5)	50.9	1.0 (0.6-1.7)
Location: Rural	38.8	33.9	1.0	34.8	1.0	23.8	1.0
Urban	61.2	66.1	1.2 (0.9-1.6)	65.2	1.2 (0.9-1.7)	76.2	2.0 (1.1-2.6)
Socioeconomic status							
Education: None	6.9	6.5	1.0	4.0	1.0	1.1	1.0
Grade 1-7	18.2	22.8	1.3 (0.7-2.4)	31.1	3.0 (1.9-4.9)	29.4	10.7 (1.4-82.2)
Grade 8-11	35.2	37.1	1.1 (0.7-1.8)	37.4	1.9 (1.2-2.9)	44.6	8.4 (1.1-6.6)
Completed high school	24.0	20.7	0.9 (0.5-1.5)	14.3	1.0 (0.6-1.8)	8.7	2.4 (0.4-14.8)
Post-high school education	15.7	12.9	0.9 (0.4-1.7)	13.3	1.5 (0.7-3.2)	16.3	6.9 (0.7-71.4)
Employed	31.5	24.1	0.7 (0.5-0.9)	31.8	1.0 (0.7-1.5)	22.0	0.6 (0.2-1.7)
Household income (mean)	59621.8	55734.8		65231.7		74210.4	
R0	13.7	11.8	1.0	17.0	1.0	15.5	1.0
R1 – 5000	29.3	31.9	1.3 (0.9-1.8)	28.4	0.8 (0.5-1.3)	25.7	0.8 (0.4-1.5)
R5001-25000	15.7	13.2	1.0 (0.6-1.5)	12.2	0.6 (0.4-1.1)	13.5	0.8 (0.2-2.5)
R25000-100000	19.3	24.1	1.4 (0.9-2.2)	17.7	0.7 (0.4-1.5)	18.9	0.9 (0.3-2.7)
R100001+	22.0	19.0	1.0 (0.6-1.6)	24.7	0.9 (0.5-1.7)	26.5	1.1 (0.4-2.7)

Table 4 (continued)

Assets owned by household: 0-5	39.2	40.8	1.0	37.4	1.0	32.3	1.0
6-12	37.1	41.9	1.1 (0.8-1.5)	40.3	1.1 (0.8-1.5)	52.3	1.7 (0.9-3.1)
13-17	23.8	17.3	0.7 (0.5-1.0)	22.3	1.0 (0.6-1.6)	15.3	0.8 (0.3-2.0)
SES Quartiles: 0	22.1	26.3	1.0	23.1	1.0	22.9	1.0
1	24.5	23.9	0.8 (0.6-1.2)	25.3	1.0 (0.7-1.5)	24.9	1.0 (0.5-1.8)
2	25.2	24.3	0.8 (0.6-1.2)	23.5	0.9 (0.6-1.3)	27.1	1.0 (0.5-2.3)
3	28.2	25.5	0.8 (0.5-1.1)	28.1	1.0 (0.6-1.6)	25.0	0.9 (0.3-2.3)
Other							
Hypertension diagnosis	15.7	26.9	2.0 (1.4-2.8)	21.2	1.4 (1.0-2.0)	31.6	2.4 (1.2-5.1)
Alcohol: Lifetime – None	78.9	69.9	1.0	67.0	1.0	61.8	1.0
Rare	5.6	6.3	1.3 (0.6-2.5)	9.6	2.0 (1.0-4.0)	10.5	2.4 (0.4-13.4)
Moderate	7.2	8.8	1.4 (0.9-2.3)	12.5	2.1 (1.2-3.4)	11.0	2.0 (0.7-5.2)
Heavy	8.4	15.0	2.0 (1.3-3.2)	10.9	1.5 (0.9-2.6)	16.7	2.5 (1.2-5.2)
Current – None	66.4	61.5	1.0	61.2	1.0	62.4	1.0
Rare	9.7	12.4	1.4 (0.8-2.3)	16.8	1.9 (1.1-3.2)	18.6	2.0 (0.5-8.1)
Moderate	16.7	17.1	1.1 (0.7-1.7)	17.3	1.1 (0.7-1.7)	15.6	1.0 (0.3-2.9)
Heavy	7.3	9.0	1.3 (0.8-2.4)	4.7	0.7 (0.3-1.6)	3.4	0.5 (0.1-2.4)
Smoking							
Lifetime smoker	29.0	34.6	1.3 (1.0-1.6)	38.9	1.6 (1.1-2.2)	27.0	0.9 (0.5-1.7)
Current smoker	23.2	24.6	1.1 (0.9-1.4)	31.1	1.5 (1.0-2.2)	19.0	0.8 (0.4-1.6)
Other chronic physical condition	40.3	59.8	2.2 (1.7-2.8)	59.8	2.2 (1.6-3.1)	67.8	3.1 (1.6-6.2)
Vascular	10.2	20.0	2.2 (1.5-3.3)	16.3	1.7 (1.1-2.6)	21.8	2.5 (1.0-5.8)
Other	37.1	57.8	2.3 (1.8-3.0)	56.2	2.2 (1.5-3.1)	64.6	3.1 (1.6-6.1)
Traumatic life events							
None	28.3	16.8	1.0	10.0	1.0	10.2	1.0
1-2	50.2	45.0	1.5 (1.0-2.2)	51.5	2.9 (1.7-4.9)	40.6	2.3 (0.9-5.6)
3-4	10.4	13.0	2.1 (1.3-3.5)	15.7	4.2 (2.4-7.6)	19.9	5.3 (1.9-14.7)
5 or more	11.1	25.2	3.8 (2.6-5.7)	22.8	5.8 (3.6-9.4)	29.4	7.4 (2.7-20.3)

* Reference group: No 12-month depression or anxiety disorder

Table 5: Prevalence of hypertension diagnosis by mental disorder

Mental Disorder (n)	Hypertension diagnosis % With mental disorder	Without health disorder	p-value	Crude* OR (95% CI)	Adjusted for demographics*+ OR (95% CI)
Lifetime					
Anxiety disorders					
Panic disorder without agoraphobia (57)	39.4	16.4	<0.001	2.37 (1.26-4.13)	1.91 (1.02-3.56)
Generalized anxiety disorder with hierarchy (167)	38.3	15.9	<0.001	3.08 (2.23-4.25)	2.42 (1.68-3.50)
Social phobia (118)	17.0	16.7	0.913	1.33(0.86-2.07)	1.49 (0.91-2.43)
Agoraphobia without panic disorder (460)	19.0	16.4	0.2413	1.38 (1.09-1.74)	1.36 (1.05-1.78)
Posttraumatic stress disorder (91)	35.0	16.3	<0.001	2.47 (1.59-3.84)	2.27 (1.37-3.75)
Depressive disorders					
Major depressive disorder(439)	20.7	16.3	0.035	1.59 (1.26-2.01)	1.35 (1.04-1.75)
Minor depressive disorder (87)	17.6	16.7	0.854	0.97 (0.55-1.71)	1.04 (0.56-1.91)
12-month					
Anxiety disorders					
Panic disorder without agoraphobia (37)	39.0	16.5	0.002	2.56 (1.30-5.05)	3.38 (2.08-5.49)
Generalized anxiety disorder with hierarchy (90)	41.0	16.2	<0.001	3.71 (2.43-5.67)	1.59 (0.91-2.76)
Social phobia (87)	19.4	16.6	0.475	1.50 (0.91-2.47)	1.55 (1.10-2.18)
Agoraphobia without panic disorder (232)	22.7	16.4	0.042	1.68 (1.24-2.28)	1.02 (0.71-1.46)
Posttraumatic stress disorder (27)	25.6	16.6	0.232	1.34 (0.54-3.33)	1.23 (0.45-3.35)
Depressive disorders					
Major depressive disorder (223)	23.0	16.4	0.002	1.83 (1.34-2.48)	1.50 (1.06-2.11)
Minor depressive disorder (26)	16.7	6.7	0.076	0.85 (0.29-2.47)	0.86 (0.27-2.69)

* No adjustment for survey design
+ Demographics includes age categories, sex, race, marital status and location

4.2.3 Bivariate associations with depressive disorders

4.2.3a Bivariate associations with lifetime depressive disorders

Lifetime depressive disorders had strong associations with sex, hypertension diagnosis, lifetime alcohol consumption, smoking, chronic physical conditions, and traumatic life events (Table 3). Women were 1.82 times more likely to have a lifetime depressive disorder than men (Figure 4). Chronic physical conditions, both vascular and non-vascular, were more common in those with a lifetime depressive disorders compared to those without lifetime

anxiety or depression. Again, a dose-response relationship appeared between traumatic life events and lifetime depressive disorders. Therefore, as the number of traumatic life events increased, so did the odds of lifetime depressive disorders. When the reference group was those without an anxiety disorder (as opposed to those with an anxiety or depressive disorder), there was no substantive differences in the odds ratios (data not shown). Furthermore, when analysis was done restricting to those with non-comorbid depression only, the prevalences and associations were not notably different (data not shown).

4.2.3b Bivariate associations with 12-month depressive disorders

The crude associations with 12-month depressive disorders are presented in Table 4 and were largely the same as the associations with lifetime depressive disorders. Indian/Asians were 2.37 times more likely (CI=1.1-5.0) to have a 12-month depressive disorders compared to Blacks. The strong associations with sex, smoking, and other chronic physical conditions, (both vascular and non-vascular) persisted, as did the dose-response relationship with traumatic life events.

4.2.3c Bivariate associations between depressive disorders and hypertension diagnosis

Hypertension diagnosis was more prevalent in those with depressive disorders; 1.42 times more likely in those with lifetime depressive disorders compared to those without a lifetime anxiety disorder or depressive disorders (Table 3). Similarly, those with a 12-month depressive disorder were 1.45 times more likely to have a hypertension diagnosis compared to those without 12-month anxiety or depressive disorders (Table 4). Those with a hypertension diagnosis were more likely to have both lifetime and 12-month major depression (Table 5). However, there was no association with lifetime or 12-month minor depression (Table 5). After adjusting for demographics, those with a hypertension diagnosis were 1.35 times more

likely to have lifetime major depression and 1.50 times more likely to have 12-month major depression (Table 5).

4.2.4 Bivariate associations with comorbid anxiety-depression

The crude associations with lifetime comorbid anxiety-depression and 12-month comorbid anxiety-depression are presented in Tables 3 and 4, respectively. Of the people with an anxiety disorder, 28% also had a depressive disorder. Of the people with depression, 37% also had an anxiety disorder (data not shown).

4.2.4a Bivariate associations with lifetime comorbid anxiety-depression

Lifetime comorbid anxiety-depression was significantly more common in women (Figure 4), and in those living in an urban area (Table 3). Those with lifetime comorbid anxiety-depression were 60% more likely to have a hypertension diagnosis compared to those with neither lifetime depression nor anxiety disorder. There was no association with smoking, but those with race, moderate and heavy alcohol consumption were more than twice as likely to have lifetime comorbid anxiety-depression compared to those without a lifetime anxiety or depressive disorder. Lifetime comorbid anxiety-depression was strongly associated with other chronic physical conditions, vascular and non-vascular, and had a dose-response relationship with traumatic life events. As traumatic life events increased, the odds of comorbid anxiety-depression increased (Table 3).

4.2.4b Bivariate associations with 12-month comorbid anxiety-depression

Associations with 12-month comorbid anxiety-depression were principally the same as those for lifetime comorbid anxiety-depression (Table 4). There was an association between 12-month comorbid anxiety-depression and Grade 1-11 education and no association with the asset index. Those with 12-month comorbid anxiety-depression were 2.48 times more likely

to have a hypertension diagnosis, and 2.54 times more likely to be a heavy drinker compared to those without 12-month anxiety or depression. The strong relationship with traumatic life events persisted, and those with 12-month comorbid anxiety-depression were 2.98 times more likely to have another chronic physical condition, 2.50 times more likely to have a vascular chronic physical condition compared to those without 12-month anxiety or depression (Table 4).

4.2.5 Bivariate associations between chronic physical conditions and mental disorders

Prevalence of a hypertension diagnosis and other chronic physical conditions in those with lifetime and 12-month mental disorders are presented in Table 6. Age-adjusted odds of hypertension diagnosis and chronic physical conditions in those with lifetime and 12-month mental disorders are presented in Table 7. Hypertension diagnosis was more common in those with either anxiety or depression, anxiety, depression, and co-morbid anxiety and depression both lifetime and 12-month, with and without adjusting for age (Table 6 & 7). Similarly, all other chronic physical conditions and hypertension diagnosis plus another chronic physical condition were also more common in those with either anxiety or depression, anxiety, depression, and co-morbid anxiety and depression both lifetime and 12-month, with and without adjusting for age (Table 6 & 7) (Figure 5). Having a hypertension diagnosis alone (hypertension diagnosis without another chronic physical condition) was not associated with any mental disorder. Vascular chronic physical conditions were more prevalent in all groups, unadjusted and adjusted for age, of mental disorders. After adjusting for age, those with lifetime depression were 1.69 times more likely, those with lifetime anxiety were 2.12 times more likely and those with lifetime comorbid anxiety-depression were 2.78 times more likely to have vascular chronic physical conditions (Table 7).

Table 6: Prevalence of chronic physical conditions by mental disorder

	No anxiety or depression	Anxiety or depression		Anxiety		Depression		Comorbid anxiety-depression	
	%	%	p-value	%	p-value	%	p-value	%	p-value
LIFETIME*									
N	3319	1032		699		526		193	
Hypertension diagnosis	15.1	21.8	<0.001	23.2	<0.001	20.2	0.010	22.2	0.010
All other chronic physical conditions	38.7	55.3	<0.001	55.4	<0.001	56.6	<0.001	58.9	<0.001
Vascular	9.7	16.0	<0.001	17.9	<0.001	15.2	0.004	20.6	<0.001
Non-vascular	35.7	51.8	<0.001	52.5	<0.001	52.1	<0.001	55.0	<0.001
Hypertension diagnosis only	3.7	3.2	0.544	3.4	0.729	2.5	0.168	1.9	21.4
Hypertension diagnosis and another chronic physical condition	11.4	18.6	<0.001	19.8	<0.001	17.7	<0.001	20.4	<0.001
No chronic physical condition	57.6	41.5	<0.001	41.3	<0.001	40.9	<0.001	39.3	<0.001
12-MONTH**									
N	3794	557		375		249		67	
Hypertension diagnosis	15.7	23.9	<0.001	26.9	<0.001	21.2	0.028	31.6	0.012
All other chronic physical conditions	40.3	58.9	<0.001	59.8	<0.001	59.8	<0.001	67.8	<0.001
Vascular	10.2	18.2	<0.001	20.0	<0.001	16.3	0.015	21.8	0.034
Non-vascular	37.1	56.3	<0.001	57.8	<0.001	56.2	<0.001	64.6	<0.001
Hypertension diagnosis only	3.7	3.2	0.663	4.2	0.736	2.2	0.234	5.4	0.498
Hypertension diagnosis and another chronic physical condition	12.0	20.7	<0.001	22.8	<0.001	19.0	0.003	26.2	0.014
No chronic physical condition	56.1	37.9	<0.001	36.0	<0.001	38.0	<0.001	26.7	<0.001

Example: 21.8% of those with a lifetime anxiety or depressive disorder have a hypertension diagnosis

* Reference group: No lifetime depressive or anxiety disorder

** Reference group: No 12-month depressive or anxiety disorder

Table 7: Age-adjusted odds ratios of chronic physical conditions by mental disorder

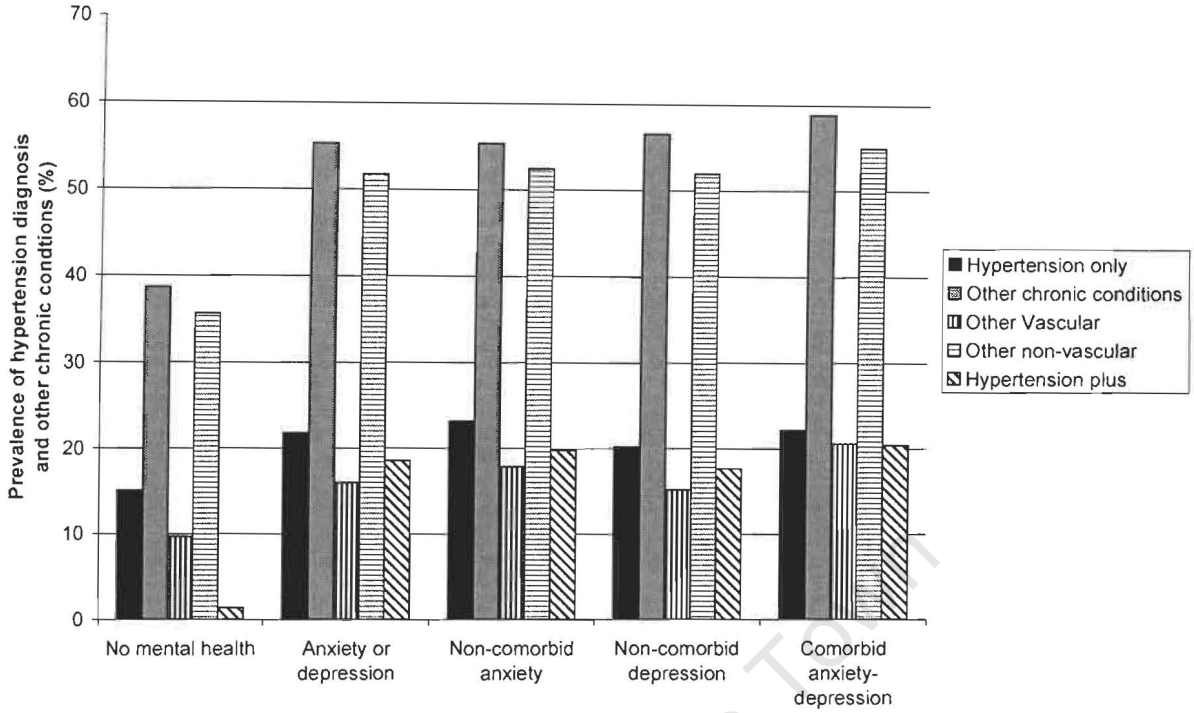
	Depression or anxiety		Anxiety		Depression		Comorbid anxiety-depression	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
LIFETIME*								
Hypertension diagnosis	1.6 (1.3-2.0)	<0.001	1.8 (1.4-2.3)	<0.001	1.4 (1.1-1.8)	0.007	1.8 (1.2-2.6)	0.003
All other chronic physical conditions	2.0 (1.6-2.4)	<0.001	2.0 (1.6-2.5)	<0.001	2.1 (1.6-2.6)	<0.001	2.4 (1.8-3.3)	<0.001
Vascular	1.8 (1.3-2.5)	0.001	2.1 (1.5-3.0)	<0.001	1.7 (1.2-2.4)	0.006	2.3 (1.7-3.2)	<0.001
Non-vascular	1.9 (1.6-2.4)	<0.001	2.0 (1.6-2.5)	<0.001	2.0 (1.6-2.5)	<0.001	2.3 (1.7-3.2)	<0.001
Hypertension diagnosis only	0.8 (0.5-1.3)	0.425	0.9 (0.5-1.5)	0.594	0.7 (0.4-1.2)	0.182	0.6 (0.2-1.6)	0.266
Hypertension diagnosis and another chronic physical condition	1.9 (1.5-2.3)	<0.001	2.1 (1.6-2.7)	<0.001	1.7 (1.3-2.2)	<0.001	2.3 (1.5-3.5)	<0.001
No chronic physical conditions	0.5 (0.4-0.6)	<0.001	0.5 (0.4-0.6)	<0.001	0.5 (0.4-0.6)	<0.001	0.4 (0.3-0.6)	<0.001
12-MONTH**								
Hypertension diagnosis	1.7 (1.3-2.2)	<0.001	2.1 (1.5-2.8)	<0.001	1.4 (1.0-2.1)	0.066	2.3 (1.1-5.0)	0.026
All other chronic physical conditions	2.1 (1.7-2.8)	<0.001	2.2 (1.7-2.9)	<0.001	2.2 (1.5-3.3)	<0.001	2.9 (1.5-5.8)	0.003
Vascular	2.0 (1.4-2.8)	<0.001	2.2 (1.5-3.4)	<0.001	1.7 (1.1-2.7)	0.031	2.2 (0.9-5.4)	0.079
Non-vascular	2.2 (1.7-2.8)	<0.001	2.3 (1.8-3.0)	<0.001	2.2 (1.5-3.1)	<0.001	2.9 (1.5-5.7)	0.003
Hypertension diagnosis only	0.8 (0.5-1.5)	0.556	1.1 (0.5-2.2)	0.845	0.7 (0.3-1.5)	0.322	1.6 (0.6-4.7)	0.374
Hypertension diagnosis and another chronic physical condition	2.0 (1.5-2.6)	<0.001	2.2 (1.6-3.2)	<0.001	1.7 (1.1-2.6)	0.014	2.3 (1.0-5.2)	0.055
No chronic physical conditions	0.5 (0.4-0.6)	<0.001	0.4 (0.3-0.6)	<0.001	0.5 (0.3-0.7)	<0.001	0.3 (0.1-0.6)	0.002

Example: Those with a lifetime anxiety or depressive disorder are 1.6 times more likely to have a hypertension diagnosis compared to those without a lifetime anxiety or depressive disorder.

* Reference group: No lifetime anxiety or depressive disorder

** Reference group: No 12-month anxiety or depressive disorder

Figure 5: Prevalence of hypertension diagnosis and other chronic physical conditions in those with mental disorders



Example: Among those without anxiety or depressive disorders, 15% had hypertension only, and almost 40% had another chronic physical condition

4.2.5a Bivariate associations between specific chronic physical conditions and mental disorders

The prevalence of specific chronic physical conditions in those with lifetime and 12-month mental disorders are presented in Tables 2 and 8, respectively. Age-adjusted odds of specific chronic physical conditions in those with lifetime and 12-month mental disorders are presented in Table 9. Adjusting for age did not attenuate any of the relationships, but strengthened some the associations between specific chronic physical conditions and mental disorders.

Those with lifetime anxiety had a significantly greater prevalence of eleven chronic physical conditions (Table 2). After adjusting for age, the high levels of physical-mental comorbidity persisted (Table 9). Those with anxiety disorders were 1.80 times more likely to have a hypertension diagnosis, after adjusting for age. After adjusting for age, those with a lifetime

anxiety disorder were more than twice as likely to have chronic pain or a heart attack in the last 12-months, and lifetime diagnosis of seven chronic physical conditions compared to those without lifetime anxiety or depression (Table 9). Those with 12-month anxiety disorders also had high comorbidity with chronic physical conditions, but to the same extent as those with lifetime anxiety (Table 8). After adjusting for age, those with a 12-month anxiety disorder had a significantly higher prevalence of eleven chronic physical conditions, whereas those with lifetime anxiety have higher prevalence of thirteen chronic physical conditions (Table 8). Depressive disorders had less physical-mental comorbidity than anxiety disorders, and 12-month depressive disorders had greater physical-mental comorbidity than lifetime depressive disorders. Age-adjusted lifetime depressive disorders were associated with arthritis, chronic back or neck problems, other chronic pain, and heart attacks in the past 12-months, as well as lifetime diagnosis of five other chronic physical conditions. Those with lifetime depressive disorders were 1.43 times more likely to have a hypertension diagnosis, after adjusting for age. The associations observed for age-adjusted lifetime depressive disorders persisted for age-adjusted 12-month depressive disorders with the exception of diabetes, and three additional chronic physical conditions had significant associations with age-adjusted 12-month depressive disorders (Table 9).

Physical-mental comorbidity was also high among those with comorbid anxiety-depression. Those with lifetime comorbid anxiety-depression were 1.80 times more likely to have a hypertension diagnosis, after adjusting for age. Eight other chronic physical conditions were also more prevalent among those with lifetime comorbid anxiety-depression after adjusting for age. The associations observed for age-adjusted lifetime comorbid anxiety-depression persisted for age-adjusted 12-month comorbid anxiety-depression with the exception of diabetes, and three additional chronic physical conditions had significant associations with age-adjusted 12-month comorbid anxiety-depression (Table 9).

Table 8: Prevalence of specific chronic physical conditions by 12-month mental disorders

12-month conditions	No anxiety or depression % (95% CI)	Anxiety or Depression % (95% CI)	p-value	Anxiety % (95% CI)	p-value	Depression % (95% CI)	p-value	Comorbid anxiety-depression % (95% CI)	p-value
Arthritis or rheumatism	9.3 (8.3-10.3)	15.5 (12.3-19.3)	<0.001	16.4 (12.8-20.9)	<0.001	14.7 (10.0-21.1)	0.021	18.0 (10.3-29.5)	0.022
Chronic back or neck problems	24.3 (22.3-16.4)	39.4 (33.8-45.2)	<0.001	39.0 (32.6-25.8)	<0.001	42.7 (34.4-51.5)	<0.001	50.1 (33.6-66.7)	0.001
Any other chronic pain	10.5 (9.1-12.0)	23.9 (19.5-28.9)	<0.001	26.2 (20.8-21.5)	<0.001	22.7 (16.9-29.7)	<0.001	32.9 (19.6-49.5)	<0.001
A stroke	1.2 (0.8-1.8)	1.6 (0.7-3.4)	0.584	1.8 (0.7-4.6)	0.484	1.2 (0.5-3.2)	0.953	1.6 (0.2-11.2)	0.786
A heart attack	3.1 (2.5-3.8)	7.8 (5.5-10.9)	<0.001	8.2 (5.4-12.3)	<0.001	7.8 (4.8-12.5)	0.001	10.5 (3.8-26.0)	0.021
Lifetime diagnosis									
Heart disease	3.1 (2.6-3.7)	8.9 (5.9-13.4)	<0.001	10.5 (6.4-16.6)	<0.001	8.0 (4.8-13.1)	0.002	14.4 (5.9-31.0)	0.002
Asthma	5.0 (4.2-6.0)	11.1 (7.7-15.6)	<0.001	12.5 (8.3-18.5)	<0.001	11.2 (6.4-18.8)	0.010	20.2 (7.5-44.2)	0.009
Hypertension	15.7 (14.3-17.2)	23.9 (20.1-28.1)	<0.001	26.9 (21.5-33.1)	<0.001	21.2 (16.2-27.2)	0.029	31.6 (18.3-48.8)	0.015
Lung disease	1.2 (0.8-1.7)	3.5 (1.7-7.1)	0.004	3.3 (1.5-6.9)	0.004	4.4 (1.5-12.5)	0.015	6.0 (1.4-22.6)	0.012
Diabetes	5.3 (4.5-6.2)	7.3 (5.1-10.1)	0.079	7.7 (5.2-11.3)	0.068	5.2 (3.0-8.8)	0.964	1.8 (0.4-8.4)	0.179
Ulcer	4.8 (3.9-5.9)	9.9 (7.8-12.5)	<0.001	10.7 (8.1-14.0)	<0.001	9.7 (5.8-15.7)	0.013	13.4 (5.8-27.9)	0.018
Thyroid disease	0.9 (0.7-1.2)	3.8 (1.9-7.5)	<0.001	4.3 (2.3-7.8)	<0.001	3.6 (1.1-10.6)	0.023	6.2 (1.5-22.0)	0.009
Neurological problem	1.3 (0.9-1.9)	2.3 (1.2-4.5)	0.100	2.0 (0.8-5.0)	0.395	3.3 (1.3-8.5)	0.053	4.3 (0.7-22.8)	0.204
Epilepsy/Seizure	0.7 (0.5-1.1)	2.0 (1.0-4.1)	0.025	3.0 (1.4-6.1)	0.002	0.3 (0.1-2.2)	0.382	1.2 (0.2-8.5)	0.650
Cancer	0.8 (5-1.4)	1.1 (0.5-2.5)	0.550	1.2 (0.4-3.2)	0.542	1.4 (0.5-3.9)	0.359	2.8 (0.6-11.6)	0.145

Example: Of those with a lifetime anxiety disorder, 39.0% reported having chronic back or neck problems in the past 12-months. People with a lifetime anxiety disorder reported significantly more chronic back or neck problems compared to those with a lifetime anxiety or depressive disorder (p-value<0.001).
* Reference group: No 12-month anxiety or depressive disorder

Table 9: Age-adjusted odds ratios of specific chronic physical conditions by mental disorder

	Depression or Anxiety OR (95% CI)	Anxiety OR (95% CI)	Depression OR (95% CI)	Comorbid anxiety-depression OR (95% CI)
LIFETIME*				
12-month conditions				
Arthritis or rheumatism	1.6 (1.2-2.0)	1.7 (1.3-2.4)	1.5 (1.0-2.1)	1.8 (1.1-2.9)
Chronic back or neck problems	1.8 (1.5-2.2)	1.8 (1.4-2.3)	1.9 (1.5-2.5)	2.5 (1.6-3.7)
Any other chronic pain	2.3 (1.7-3.1)	2.6 (1.8-3.6)	2.4 (1.7-3.3)	3.4 (2.1-5.6)
A stroke	0.9 (0.4-2.0)	1.1 (0.4-2.7)	0.7 (0.2-2.0)	1.0 (0.2-5.8
A heart attack	1.9 (1.3-2.9)	2.4 (1.5-3.7)	1.9 (1.1-3.4)	3.3 (1.8-6.0)
Lifetime diagnosis				
Heart disease	2.1 (1.3-3.5)	2.8 (1.6-4.6)	1.9 (1.2-3.0)	4.2 (2.2-8.1)
Asthma	1.8 (1.3-2.6)	2.0 (1.3-3.0)	1.9 (1.2-3.0)	2.7 (1.5-5.2)
Hypertension	1.6 (1.3-2.0)	1.8 (1.4-2.3)	1.4 (1.1-1.8)	1.8 (1.2-2.6)
Lung disease	2.5 (1.2-5.0)	2.4 (1.2-5.0)	2.4 (0.9-6.3)	2.2 (0.8-5.9)
Diabetes	1.7 (1.2-2.5)	1.89(1.3-2.7)	1.5 (1.0-2.4)	1.8 (1.1-3.2)
Ulcer	2.2 (1.5-3.1)	2.1 (1.5-3.1)	2.1 (1.3-3.4)	2.0 (1.0-4.2)
Thyroid disease	2.7 (1.3-5.6)	2.7 (1.4-5.2)	2.5 (0.9-7.1)	2.2 (0.5-8.5)
Neurological problems	2.3 (1.2-4.2)	2.6 (1.3-4.9)	2.0 (0.9-4.4)	2.5 (0.8-7.9)
Epilepsy/Seizure	3.1 (1.5-6.3)	4.5 (2.2-9.4)	1.2 (0.5-2.7)	3.2 (1.4-7.5)
Cancer	1.5 (0.6-4.0)	1.8 (0.6-5.3)	1.3 (0.4-4.0)	2.2 (0.6-8.5)
12-MONTH**				
12-month conditions				
Arthritis or rheumatism	1.8 (1.3-2.5)	1.9 (1.3-2.8)	1.7 (1.1-2.7)	1.9 (1.0-3.6)
Chronic back or neck problems	2.0 (1.5-2.6)	2.0 (1.5-2.6)	2.3 (1.6-3.4)	3.0 (1.5-5.8)
Any other chronic pain	2.6 (2.0-3.5)	3.0 (2.2-4.1)	2.4 (1.6-3.7)	3.0 (2.0-7.7)
A stroke	1.2 (0.5-3.1)	1.4 (0.5-4.2)	1.0 (0.3-2.8)	1.1 (0.1-9.1)
A heart attack	2.6 (1.7-3.8)	2.7 (1.7-4.2)	2.6 (1.5-4.6)	3.2 (1.1-9.6)
Lifetime diagnosis				
Heart disease	3.1 (1.8-5.3)	3.6 (2.0-6.8)	2.7 (1.4-5.2)	4.8 (1.7-14.1)
Asthma	2.3 (1.5-3.6)	2.7 (1.6-4.4)	2.3 (1.2-4.5)	4.5 (1.4-15.0)
Hypertension	1.7 (1.3-2.2)	2.1 (1.5-2.8)	1.4 (1.0-2.1)	2.3 (1.1-5.0)
Lung disease	3.0 (1.4-6.4)	2.8 (1.4-5.8)	4.0 (1.4-11.9)	5.1 (1.3-20.2)
Diabetes	1.3 (0.9-2.0)	1.4 (0.9-2.1)	0.9 (0.5-1.7)	0.3 (0.1-1.3)
Ulcer	2.1 (1.5-3.0)	2.3 (1.5-3.4)	2.0 (1.1-3.7)	2.8 (1.1-7.4)
Thyroid disease	4.5 (2.0-10.3)	5.1 (2.5-10.2)	4.2 (1.3-14.2)	7.4 (1.7-32.2)
Neurological problem	1.8 (0.9-3.7)	1.5 (0.5-4.2)	2.6 (1.0-6.9)	3.2 (0.5-21.8)
Epilepsy/Seizure	2.7 (1.2-6.5)	4.1 (1.7-9.8)	0.4 (0.1-3.2)	1.7 (0.2-13.4)
Cancer	1.3 (0.5-3.6)	1.3 (0.4-4.4)	1.7 (0.5-6.1)	3.0 (0.5-17.1)

Example: After adjusting for age, those with a 12-month depressive disorder were 2.6 times more likely to report having a heart attack in the past 12-months compared to those with a 12-month anxiety or depressive disorder.

* Reference group: No lifetime anxiety or depressive disorder

** Reference group: No 12-month anxiety or depressive disorder

4.3 Multivariate Analysis

4.3.1 Models predicting mental disorders

Multivariate models were constructed to assess the independent association between hypertension diagnosis and anxiety disorders, depressive disorders, and comorbid anxiety-depressive both for lifetime and 12-month disorders. In addition, models were built with a) hypertension diagnosis as a binary yes/no variable, and b) hypertension diagnosis as a four-level categorical variable with other chronic physical conditions: no chronic physical condition, hypertension diagnosis only, hypertension diagnosis plus another chronic physical condition, another chronic physical condition. Each model had five levels, Model A- Model E, including progressively more variables (Table 10).

Table 10: Summary of variables in multivariate models predicting mental disorders

Model name	Variables Included
Model A	Demographics*
Model B	Demographics* and socioeconomic measure+
Model C	Demographics*, socioeconomic measure+, lifetime smoking and alcohol use
Model D	Demographics*, socioeconomic measure+, lifetime smoking and alcohol use, and substance use disorder^
Model E	Demographics*, socioeconomic measure+, lifetime smoking and alcohol use, substance use disorder^ and traumatic life events

* Demographics include age categories, sex, race, location and marital status
+Socioeconomics were summarized in an aggregate measure comprised from income, education and assets
^ Substance use disorder included any of the following: lifetime *DSM-IV* diagnosis of alcohol abuse (with and without depression), alcohol dependence with abuse, drug abuse (with and without depression) and drug dependence with abuse

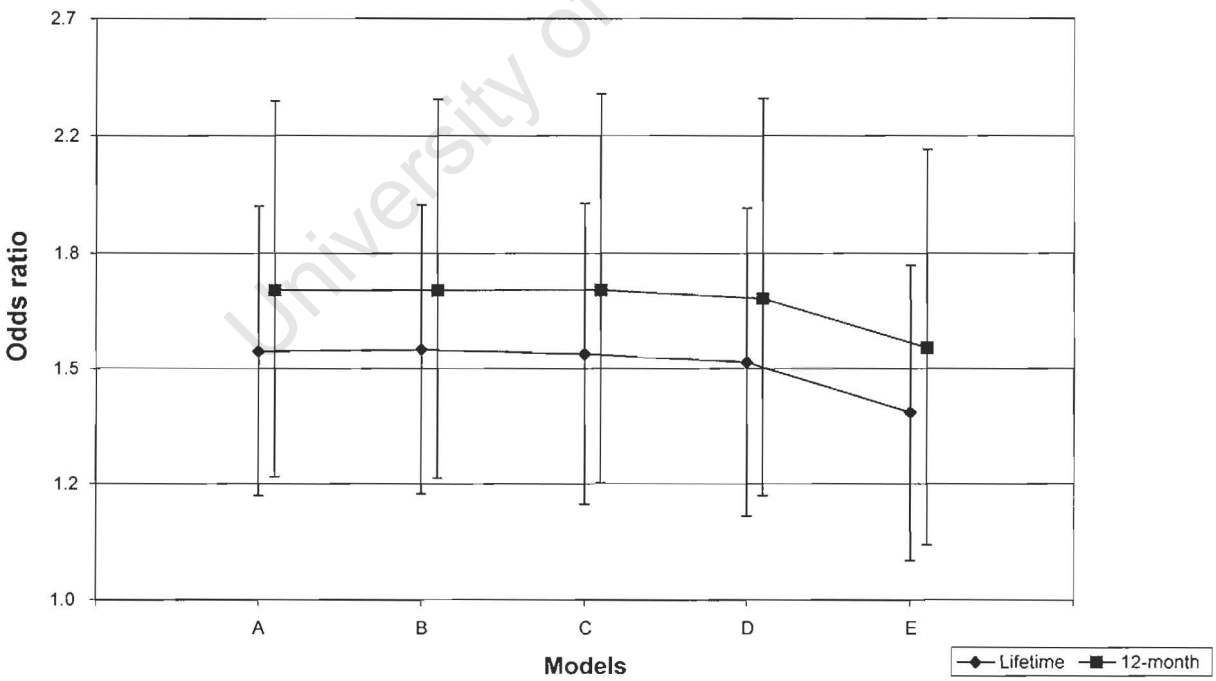
The aggregate measure of SES was utilized in the models because no SES measure was consistently and strongly associated with mental health in the bivariate analysis. The results of Model B where SES is added to the logistic regression models using all SES measures versus the SES aggregate measure are presented in Appendix K. In all cases, there was not a significant difference between using all measures of SES versus the SES aggregate measure (data not shown).

4.3.2 Multivariate models predicting anxiety disorders

4.3.2a Multivariate models predicting anxiety disorders from hypertension diagnosis

In multivariate analysis, the association between lifetime anxiety disorders and hypertension diagnosis persisted after adjustment for age, sex, race, marital status and location; SES; lifetime smoking and alcohol consumption; substance abuse disorders and traumatic life events (Table 11). In this final model, those with a hypertension diagnosis are 1.38 times more likely to have a lifetime anxiety disorder and 1.55 times more likely to have a 12-month anxiety disorder (Table 11). When analysis was limited to Blacks only, none of the associations were substantively different (data not shown). Figure 6, with the odds ratios and 95% confidence intervals for the lifetime and 12-month models for anxiety disorders, displays how the association decreases in Models D and E but remains significant across all models (odds ratio is always greater than 1).

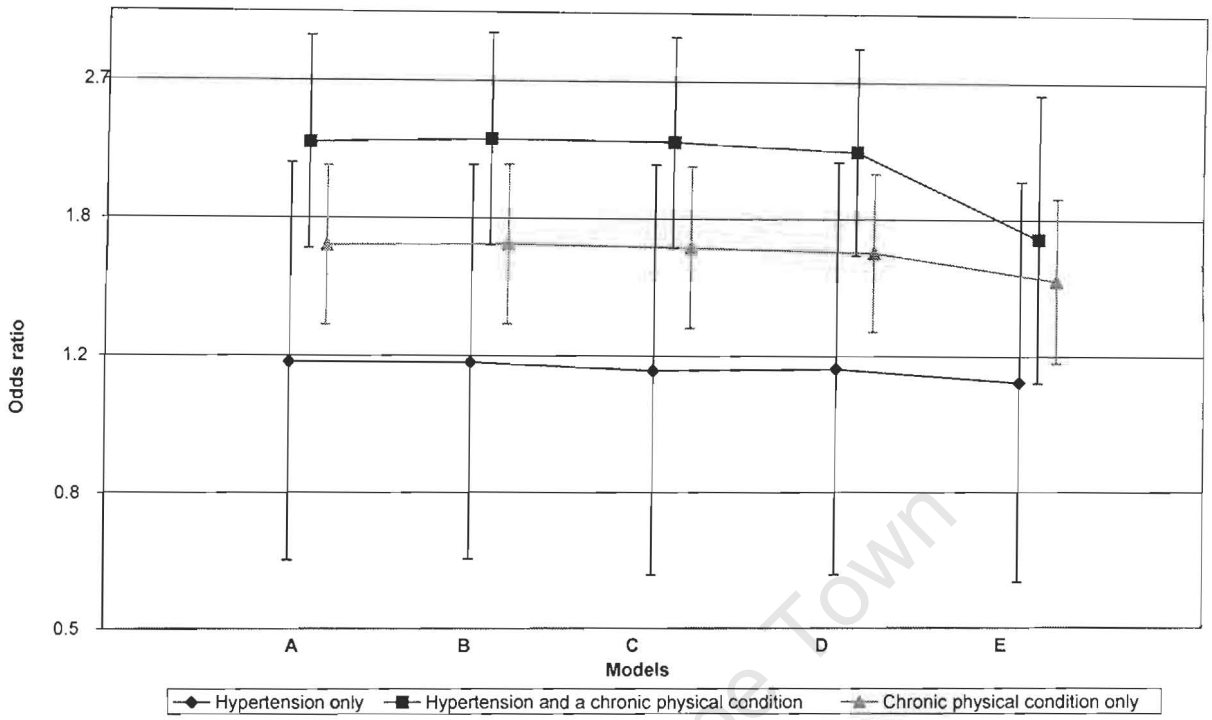
Figure 6: Adjusted odds ratios for hypertension predicting anxiety disorders



4.3.2b Multivariate models predicting anxiety disorders from hypertension diagnosis and other chronic physical conditions

The second set of models predicted anxiety disorders with hypertension diagnosis as a categorical variable including other chronic physical conditions. Hypertension diagnosis only was not associated with lifetime or 12-month anxiety disorders in any of the models (Table 11, Figure 7). After adjusting for demographics, there was a strong positive association between hypertension diagnosis and another chronic physical condition and lifetime anxiety disorder. This positive association persisted after adjustment for all variables including traumatic life events (Figure 7). After adjustment, those with a hypertension diagnosis and another chronic physical condition were 92% more likely to have a lifetime anxiety disorder compared to those without any chronic physical condition (Table 11). This association was even stronger in the model for 12-month anxiety disorders; the odds of a 12-month anxiety disorder were 2.25 times higher in those with a hypertension diagnosis and another chronic physical condition. In models stratified by sex, the association between hypertension diagnosis and other chronic physical condition persisted in both men and women (Appendixes L and M). When analysis was limited to Blacks only, none of the associations were substantively different (data not shown).

Figure 7: Adjusted odds ratios for hypertension and other chronic physical conditions predicting anxiety disorders



4.3.2c Other independent predictors of anxiety disorders

Female sex and living in an urban location were both strong independent predictors of both 12-month and lifetime anxiety disorders both in models with hypertension diagnosis as binary and categorical variable. In the final model for categorical hypertension predicting lifetime anxiety disorders, females were 2.47 times more likely to have a lifetime anxiety disorder compared to males (Table 12). Those living in an urban area were 1.33 (1.07-1.65) times more likely to have a lifetime anxiety disorder compared to those living in an urban area after adjustment (Table 12). Compared to Black people, White and Coloured people had a decreased odds of having a lifetime anxiety disorder (Table 12). Other independent predictors of lifetime anxiety disorders were rare and heavy alcohol consumption of less than once a month (p-value=0.012) and 3-7 days per week (p-value=0.027) (data not shown). Those with a substance abuse disorder were more than twice as likely to have a lifetime anxiety disorder (Table 12). Furthermore, as the number of traumatic life time events increased, the odds of

lifetime anxiety disorders increased. Those with 1-2 events were 1.50 times more likely those with 3-4 events were 1.69 times more likely and those with 5 or more events were 2.58 times more likely to have a lifetime anxiety disorder compared to those with no traumatic life events (Table 12).

Table 11: Summary of multivariate models predicting anxiety disorders

	(A) Demographics		(B) Demographics and socioeconomic		(C) Demographics, socioeconomic, lifetime smoking and alcohol		(D) Demographics, socioeconomic, lifetime smoking and alcohol, substance abuse disorders		(E) Demographics, socioeconomic, lifetime smoking and alcohol, substance abuse disorders, traumatic life events	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
LIFETIME anxiety disorders – Hypertension										
Hypertension diagnosis	1.53	1.19-1.98	1.54	1.20-1.98	1.53	1.18-1.98	1.51	1.16-1.97	1.38	1.07-1.79
12-MONTH anxiety disorders – Hypertension										
Hypertension diagnosis	1.71	1.24-2.36	1.71	1.23-2.37	1.71	1.22-2.39	1.69	1.20-2.37	1.55	1.10-2.18
LIFETIME anxiety disorders – Hypertension and chronic physical conditions										
Hypertension diagnosis only	1.20	0.67-2.14	1.20	0.67-2.14	1.17	0.64-2.13	1.18	0.64-2.16	1.13	0.63-2.04
Hypertension diagnosis and another chronic physical condition	2.27	1.67-3.09	2.30	1.69-3.12	2.28	1.67-3.10	2.22	1.63-3.01	1.92	1.41-2.63
Chronic only	1.68	1.34-2.12	1.679	1.34-2.13	1.68	1.32-2.12	1.65	1.31-2.08	1.52	1.208-1.94
12-MONTH anxiety disorders – Hypertension and chronic physical conditions										
Hypertension diagnosis only	1.65	0.77-3.51	1.64	0.77-3.51	1.61	0.74-3.52	1.63	0.74-3.55	1.58	0.74-3.38
Hypertension diagnosis and another chronic physical condition	2.66	1.79-3.95	2.66	1.78-3.98	2.66	1.78-3.99	2.58	1.72-3.86	2.25	1.46-3.45
Chronic only	1.92	1.44-2.57	1.92	1.43-2.57	1.89	1.40-2.55	1.86	1.39-2.49	1.74	1.28-2.37

Example: After adjusting for demographics, those with a hypertension diagnosis are 1.49 more likely to have a lifetime anxiety disorder compared to those without a hypertension diagnosis.

Table 12: Summary of final multivariate models for hypertension diagnosis and other chronic physical conditions predicting lifetime anxiety disorders, depressive disorders, and comorbid anxiety-depression

	Anxiety		Depression		Comorbid anxiety-depression	
	OR	95% CI	OR	95% CI	OR	95% CI
Hypertension status						
None	1.0		1.0		1.0	
Hypertension diagnosis only	1.13	0.63-2.04	0.84	0.45-1.54	0.75	0.26-2.19
Hypertension diagnosis and chronic	1.92	1.41-2.63	1.46	1.06-2.03	1.77	1.13-2.77
Chronic only	1.52	1.20-1.94	1.53	1.18-1.98	1.59	1.06-2.38
Age: 18-29	1.0		1.0		1.0	
30-39	1.02	0.77-1.36	1.11	0.84-1.47	0.94	0.61-1.45
40-49	0.90	0.64-1.28	1.40	1.04-1.89	1.00	0.60-1.67
50+	0.90	0.59-1.35	0.84	0.60-1.19	0.70	0.39-1.26
Sex :Male	1.0		1.0		1.0	
Female	2.47	1.91-3.19	2.50	1.77-3.52	3.67	2.12-6.34
Race Black	1.0		1.0		1.0	
Coloured	0.71	0.47-1.07	0.86	0.58-1.28	0.62	0.37-1.03
White	0.51	0.27-0.97	0.79	0.48-1.31	0.57	0.24-1.38
Indian/Asian	0.52	0.28-0.97	1.37	0.75-2.49	0.68	0.36-1.31
Currently married	0.94	0.72-1.22	0.91	0.70-1.20	0.83	0.58-1.20
Location: Rural	1.0		1.0		1.0	
Urban	1.33	1.07-1.65	1.09	0.84-1.41	1.94	1.35-2.78
SES Quartile – 0	1.0		1.0		1.0	
1	0.95	0.72-1.25	0.78	0.59-1.02	0.88	0.54-1.44
2	1.04	0.77-1.41	0.87	0.65-1.15	0.81	0.51-1.30
3	1.17	0.84-1.64	1.00	0.72-1.39	1.06	0.54-2.06
Alcohol: Lifetime – None	1.0		1.0		1.0	
Rare	1.78	1.14-2.74	2.03	1.37-3.00	2.78	1.37-5.67
Moderate	1.25	0.79-1.97	1.93	1.23-3.01	2.24	1.19-4.24
Heavy	1.84	1.07-3.17	1.09	0.69-1.72	1.83	1.06-3.18
Lifetime smoker	1.15	0.92-1.43	1.50	1.11-2.03	1.30	0.83-2.04
Substance use disorder	2.10	1.21-3.64	1.88	1.31-2.69	1.85	0.97-3.53
Traumatic life events – None	1.0		1.0		1.0	
1-2	1.50	1.10-2.03	1.98	1.41-2.78	1.66	0.97-2.79
3-4	1.69	1.16-2.46	2.99	1.93-4.63	3.11	1.68-5.77
5 or more	2.58	1.83-3.64	3.68	2.31-5.85	4.31	2.31-8.05

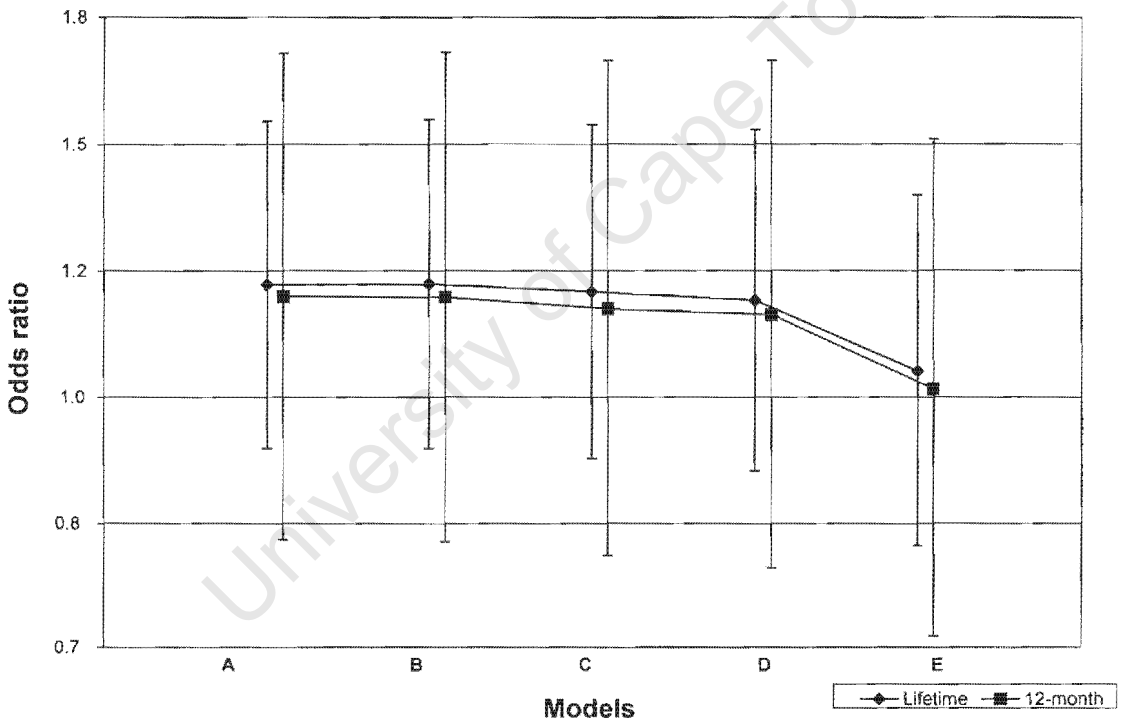
Example: After adjusting for hypertension and other chronic physical conditions, demographics, SES, lifestyle factors and traumatic life events, those with a substance use disorder are 2.10 times more likely to have a lifetime anxiety disorder compared to those without a substance use disorder.

4.3.3 Multivariate models predicting depressive disorders

4.3.3a Multivariate models predicting depressive disorders from hypertension diagnosis

In multivariate analysis of hypertension predicting lifetime and 12-month depressive disorders, hypertension diagnosis was not associated with depressive disorders in any of the models (Table 13). This is illustrated in Figure 8, where the confidence interval of the odds ratio for hypertension diagnosis predicting depressive disorders always overlaps with 1. When analysis was limited to Blacks only, none of the associations were substantively different (data not shown).

Figure 8: Adjusted odds ratios for hypertension predicting depressive disorders

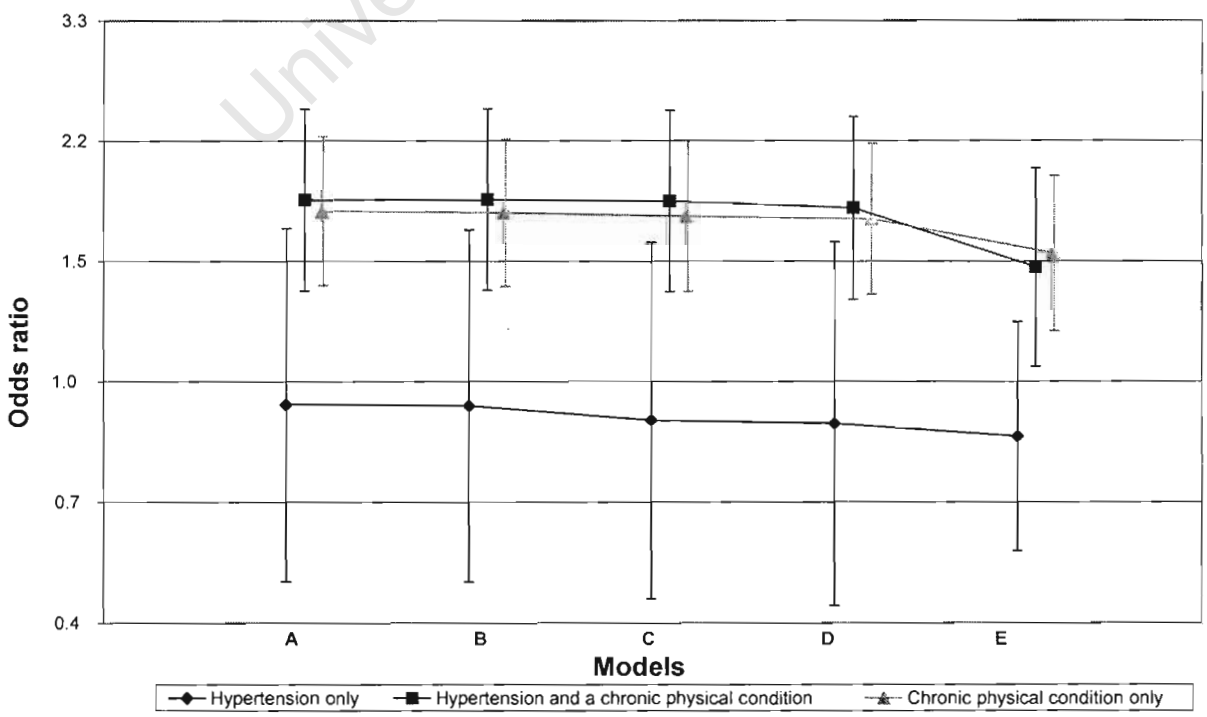


4.3.3b Multivariate models predicting depressive disorders from hypertension diagnosis and other chronic physical conditions

Similarly, hypertension diagnosis alone was not associated with depressive disorders in any of the models with hypertension diagnosis and other chronic physical conditions (Table 13) (Figure 9). However, hypertension diagnosis and another chronic physical condition was an

independent predictor of lifetime depression (Table 13). In the final model, those with a hypertension diagnosis and another chronic physical condition were 1.46 times more likely to have a lifetime depressive disorder compared to those without any chronic physical condition (Table 13) (Figure 9). When the models were stratified by sex, women with a hypertension diagnosis and another chronic physical condition were 1.92 times more likely to have a depressive disorder compared to those without any chronic physical conditions (Appendix M). However, there was no association for men between hypertension diagnosis and another chronic physical conditions and depressive disorders (Appendix L). The relationship of a hypertension diagnosis plus another chronic physical condition and depression also existed for 12-month depression. However, in the final model of 12-month depression, the adjustment for traumatic life events attenuated the relationship with hypertension diagnosis and another chronic physical condition and made it not significant (p-value=0.117) (Table 13). When analysis was limited to Blacks only, none of the associations were substantively different (data not shown).

Figure 9: Adjusted odds ratios for hypertension and other chronic physical conditions predicting lifetime depressive disorders



4.3.3c Other independent predictors of depressive disorders

In all the models predicting lifetime and 12-month depressive disorders, females were far more likely to have a depressive disorder than males. In Model E predicting lifetime depression with hypertension diagnosis and other chronic physical conditions, females were 2.50 times more likely to have depression compared to men (Table 12). Rare and moderate lifetime drinking, lifetime smoking and traumatic life events were also independent predictors of depressive disorders (Table 12). There was also an increased odds of depression with increased number of traumatic life events. These associations were all highly significant will p-values all less than 0.001 in the final model with categorical hypertension diagnosis and lifetime depression (data not shown). In models for 12-month depressive disorders, there was also an independent association with the race group Indian/Asian (data not shown). In final model for 12-month depressive disorders and binary hypertension diagnosis, Indians/Asians were 2.12 times more likely to have a depressive disorder compared to Blacks but this association was not significant (p-value = 0.216) in the final model with categorical hypertension diagnosis (data not shown).

Table 13: Summary of multivariate models predicting depressive disorders

	(A) Demographics		(B) Demographics and socioeconomic		(C) Demographics, socioeconomic, lifetime smoking and alcohol		(D) Demographics, socioeconomic, lifetime smoking and alcohol, substance abuse disorders		(E) Demographics, socioeconomic, lifetime smoking and alcohol, substance abuse disorders, traumatic life events	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
LIFETIME depressive disorders – Hypertension										
Hypertension diagnosis	1.19	0.92-1.55	1.20	0.92-1.55	1.18	0.91-1.54	1.17	0.89-1.53	1.04	0.79-1.38
12-MONTH depressive disorders – Hypertension										
Hypertension diagnosis	1.17	0.80-1.72	1.17	0.79-1.72	1.15	0.78-1.70	1.14	0.76-1.70	1.01	0.68-1.50
LIFETIME depressive disorders – Hypertension and other chronic physical conditions										
Hypertension diagnosis only	0.93	0.52-1.66	0.92	0.51-1.67	0.88	0.49-1.59	0.87	0.48-1.59	0.83	0.45-1.54
Hypertension diagnosis and another chronic physical condition	1.83	1.35-2.48	1.83	1.35-2.47	1.82	1.35-2.46	1.78	1.31-2.42	1.46	1.06-2.03
Chronic only	1.76	1.38-2.26	1.75	1.37-2.24	1.74	1.36-2.23	1.72	1.34-2.20	1.53	1.18-1.98
12-MONTH depressive disorders – Hypertension and other chronic physical conditions										
Hypertension diagnosis only	0.90	0.40-2.02	0.90	0.50-2.02	0.85	0.37-1.95	0.84	0.36-1.96	0.81	0.35-1.87
Hypertension diagnosis and another chronic physical condition	1.84	1.15-2.93	1.84	1.15-2.95	1.81	1.14-2.86	1.79	1.12-2.85	1.44	0.91-2.29
Chronic only	1.81	1.25-2.62	1.81	1.25-2.61	1.78	1.22-2.59	1.77	1.21-2.57	1.56	1.07-2.26

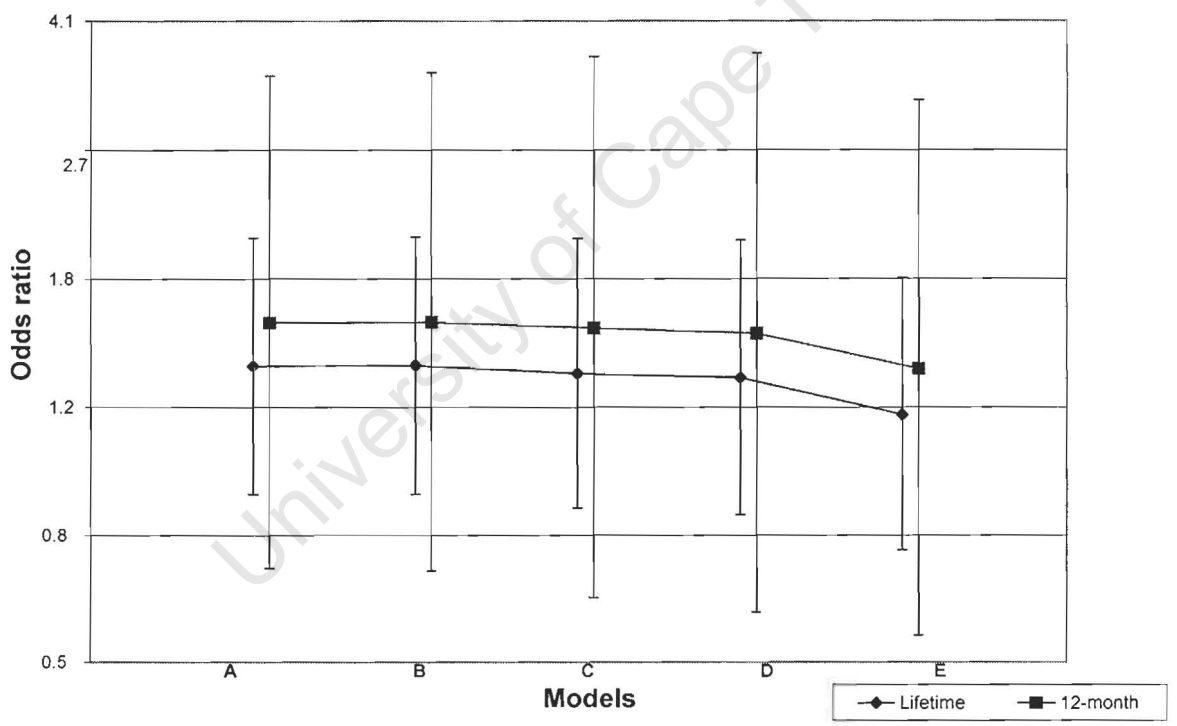
**Example*: After adjusting for demographics and socioeconomic status, those with a hypertension diagnosis and another chronic physical condition are 1.83 times more likely to have a lifetime depressive disorder compared to those without any chronic physical conditions.

4.3.4 Multivariate models predicting comorbid anxiety-depression

4.3.4a Multivariate models predicting comorbid anxiety-depression from hypertension diagnosis

In multivariate analysis of binary hypertension diagnosis predicting lifetime and 12-month comorbid anxiety-depression, hypertension diagnosis was not associated with comorbid anxiety-depression in any of the models (Table 14). This is illustrated in Figure 10, where the confidence interval of the odds ratio for a hypertension diagnosis predicting comorbid anxiety-depression always overlaps with 1. When analysis was limited to Blacks only, none of the associations were substantively different (data not shown).

Figure 10: Adjusted odds ratios for hypertension predicting comorbid anxiety-depression

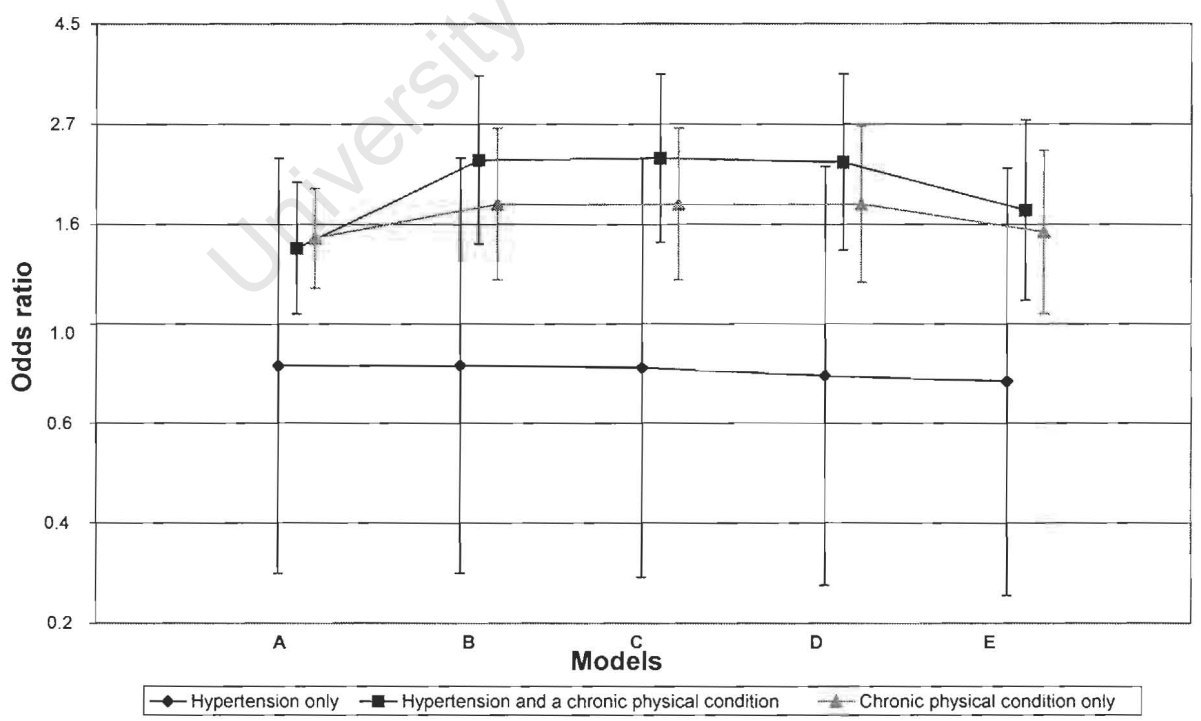


4.3.4b Multivariate models predicting comorbid anxiety-depression from hypertension diagnosis and other chronic physical conditions

In the multivariate analysis with hypertension diagnosis and other chronic physical conditions as a four-level categorical variable, hypertension diagnosis only was not associated with

comorbid anxiety-depression in any of the models (Table 14) (Figure 11). However, those with comorbid anxiety-depression were more likely to have a hypertension diagnosis and another chronic physical condition after adjustment for demographics, socioeconomics, lifetime smoking and alcohol use, and substance abuse disorders (Table 14). Adjusting for traumatic life events attenuates the relationship but it still remains significant (p-value=0.013) (Figure 11). The relationship between 12-month comorbid anxiety-depression is significant in model C, (OR=2.62, 95% CI=1.17-5.82), but subsequent adjustment for substance use disorders and traumatic makes the association non-significant (Table 14). When the models were stratified by sex, a strong association between hypertension diagnosis and another chronic physical condition persisted for women (OR=2.07, 95% CI=1.21-3.56), but was non-significant for men (OR=1.03, 95% CI=0.33-3.27) (Appendixes L and M). When analysis was limited to Blacks only, none of the associations were substantively different (data not shown).

Figure 11: Adjusted odds ratios for hypertension and other chronic physical conditions predicting lifetime comorbid anxiety-depression



4.3.4c Other independent predictors of comorbid anxiety-depression

Female sex and living in an urban area were also strong independent predictors of lifetime and 12-month comorbid anxiety-depression in all models. In Model E predicting lifetime comorbid anxiety-depression from hypertension diagnosis and other chronic physical conditions, women were 3.67 times more likely to have comorbid anxiety-depression compared to men and those in an urban area were 1.94 times more likely to have comorbid anxiety-depression compared to those in urban areas (Table 14). Heavy lifetime drinking and traumatic life events were strong predictors of comorbid anxiety-depression in all models.

Table 14: Summary of multivariate models predicting comorbid anxiety-depression

	(A) Demographics		(B) Demographics and socioeconomic		(C) Demographics, socioeconomic, lifetime smoking and alcohol		(D) Demographics, socioeconomic, lifetime smoking and alcohol, substance abuse disorders		(E) Demographics, socioeconomic, lifetime smoking and alcohol, substance abuse disorders, traumatic life events	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Lifetime comorbid anxiety-depression – Hypertension										
Hypertension diagnosis	1.39	0.93-2.07	1.40	0.93-2.08	1.36	0.89-2.06	1.34	0.87-2.05	1.19	0.78-1.83
12-month comorbid anxiety-depression – Hypertension										
Hypertension diagnosis	1.59	0.74-3.41	1.59	0.73-3.47	1.56	0.67-3.65	1.54	0.65-3.66	1.38	0.60-3.18
Lifetime comorbid anxiety-depression – Hypertension and other chronic physical conditions										
Hypertension diagnosis only	0.81	0.29-2.28	0.80	0.28-2.28	0.77	0.27-2.19	0.77	0.27-2.21	0.75	0.26-2.19
Hypertension diagnosis and another chronic physical condition	2.28	1.50-2.45	2.30	1.52-3.48	2.26	1.46-3.48	2.20	1.41-3.43	1.77	1.13-2.77
Chronic only	1.83	1.25-2.68	1.82	1.25-2.67	1.83	1.23-2.70	1.80	1.21-2.68	1.59	1.06-2.38
12-month comorbid anxiety-depression – Hypertension and other chronic physical conditions										
Hypertension diagnosis only	2.70	0.79-9.28	2.71	0.79-9.28	2.77	0.81-9.56	2.79	0.81-9.63	2.74	0.81-9.22
Hypertension diagnosis and another chronic physical condition	2.69	1.11-6.54	2.71	1.08-6.83	2.67	1.02-7.00	2.59	0.96-7.05	2.14	0.82-5.63
Chronic only	2.51	1.12-5.63	2.53	1.12-5.74	2.62	1.17-5.82	2.60	1.16-5.81	2.35	1.10-5.01

Example: After adjusting for demographics, those with another chronic physical condition (other than hypertension) are 1.83 times more likely to have lifetime comorbid anxiety-depression compared to those with no chronic physical conditions.

4.3.5 Multivariate models predicting hypertension diagnosis

Three models were built to predict hypertension diagnosis from lifetime and 12-month mental disorders and adjust for other chronic physical conditions. The logistic regression models predicted hypertension diagnosis (binary) from mental health as a four level categorical variable; no mental disorder (no anxiety or depression), non-comorbid anxiety, non-comorbid depression, and comorbid anxiety-depression. Each model had three levels, Model A- Model C, including progressively more variables (Table 15).

Table 15: Summary of variables in multivariate models predicting hypertension diagnosis

Model name	Variables Included
Model A	None (crude association)
Model B	Demographics*
Model C	Demographics* & other chronic physical conditions

* Demographics include age categories, sex, race, location and marital status

The results of the models predicting hypertension diagnosis from mental disorders, both lifetime and 12-month, are presented in Table 16. There was a crude positive association with lifetime non-comorbid anxiety and hypertension diagnosis, and lifetime comorbid anxiety-depression and hypertension diagnosis. The positive association between non-comorbid anxiety and hypertension diagnosis persisted after adjusting for demographics and for other chronic physical conditions. However, after adjustment for demographics and other chronic physical conditions there was no association with comorbid anxiety-depression and hypertension diagnosis. In the final Model C, age, sex, and other chronic physical conditions had independent associations with hypertension diagnosis (Table 17).

Table 16: Summary of multivariate models predicting hypertension diagnosis

	(A) Unadjusted		(B) Adjusted for demographics		(C) Adjusted for demographics and other chronic physical conditions	
	OR	95% CI	OR	95% CI	OR	95% CI
LIFETIME						
No MH	1.0		1.0		1.0	
Non-comorbid anxiety	1.73	1.29-2.31	1.62	1.19-2.19	1.38	1.00-1.89
Non-comorbid depression	1.31	0.92-1.87	1.21	0.84-1.75	1.00	0.70-1.43
Comorbid anxiety-depression	1.60	1.12-2.29	1.51	1.01-2.25	1.18	0.77-1.80
12-MONTH						
No MH	1.0		1.0		1.0	
Non-comorbid anxiety	1.89	1.34-2.65	1.77	1.25-2.50	1.52	1.05-2.21
Non-comorbid depression	1.15	0.77-1.72	1.10	0.70-1.73	0.93	0.60-1.48
Comorbid anxiety-depression	2.48	1.20-5.14	1.76	0.83-3.71	1.38	0.63-3.04

Example: After adjusting for demographics, those with a non-comorbid 12-month anxiety disorder are 1.77 times more likely to have a hypertension diagnosis compared to those without a 12-month anxiety or depressive disorder.

Table 17: Final multivariate model predicting hypertension diagnosis

	Hypertension diagnosis	
	OR	95% CI
Mental Health (Lifetime)		
No MH	1.0	
Non-comorbid anxiety	1.38	1.00-1.89
Non-comorbid depression	1.00	0.70-1.43
Comorbid anxiety-depression	1.18	0.77-1.80
Age: 18-29	1.0	
30-39	2.35	1.61-3.43
40-49	5.42	3.37-8.71
50+	13.62	9.09-20.42
Sex :Male	1.0	
Female	2.36	1.80-3.10
Race: Black	1.0	
Coloured	1.00	0.69-1.46
White	0.73	0.47-1.15
Indian/Asian	0.37	0.15-0.92
Currently married	1.07	0.83-1.36
Location: Rural	1.0	
Urban	1.01	0.78-1.32
Chronic physical conditions	4.04	3.16-5.16

Example: After adjusting for demographics, and lifetime anxiety and depressive disorders, those with another chronic physical condition are 4.0 times more likely to have a hypertension diagnosis compared to those without a chronic physical condition.

4.4 Analysis of timing of onset of mental disorders

4.4.1 Prevalence of hypertension diagnosis relative to current age and age of onset of mental disorder(s)

4.4.1a Anxiety

There was no difference in the prevalence of hypertension diagnosis in those without anxiety, compared to those whose onset of an anxiety disorder was in the previous ten years (Table

18). However, those whose onset of an anxiety disorder was longer than ten years ago were 2.16 times more likely to have a hypertension diagnosis compared to those without an anxiety disorder. This pattern persisted when analysis was restricted to those whose current age was 35 years or younger. Among those currently older than 35, those whose onset on an anxiety disorder is 4 or more years ago, are more likely to have a hypertension diagnosis compared those who do not have an anxiety disorder (Table 18).

Table 18: Prevalence of hypertension diagnosis by time since onset of an anxiety disorder, compared to individuals with no anxiety disorder

	Hypertension diagnosis			
	%	95% CI	OR	p-value
		OVERALL		
No anxiety	15.5	14.0-17.1	1.0	
0-3	18.2	10.5-29.7	1.22	0.556
4-10	13.2	9.3-18.5	0.83	0.355
10+	28.3	24.0-33.1	2.16	<0.001
		Currently 35 or younger		
No anxiety	4.7	3.7-6.0	1.0	
0-3	4.6	1.4-13.6	0.97	0.966
4-10	5.0	2.2-10.9	1.07	0.879
10+	9.6	5.9-15.3	2.16	0.005
		Currently older than 35 years		
No anxiety	28.2	24.9-31.7	1.0	
0-3	41.0	23.0-66.0	1.77	0.192
4-10	38.7	33.1-44.5	2.61	0.004
10+	30.2	27.5-33.0	1.61	0.006

Example: 28.3% of those whose onset of an anxiety disorder was 10 or more years ago have a hypertension diagnosis. Those whose onset of an anxiety disorder was 10 or more years are 2.16 times more likely to have a hypertension diagnosis compared to those without an anxiety disorder.

4.4.1b Depression

Similar to those with an anxiety disorder, there was no difference in the prevalence of hypertension diagnosis in those without depression, compared to those whose onset of depression was in the previous ten years (Table 19). However, those whose onset of depression was longer than ten years ago were 1.86 times more likely to have a hypertension diagnosis compared to those without depression. Among those whose current age was 35 or less, a similar association exists. Only those whose onset of depression was longer than ten years ago were more likely to have a hypertension diagnosis. For those whose current age is greater than 35, there was no association with the time since onset of depression and prevalence of hypertension diagnosis (Table 19).

Table 19: Prevalence of hypertension diagnosis by time since onset of a depressive disorder, compared to individuals with no depressive disorder

	Hypertension diagnosis			
	%	95% CI	OR	p-value
		OVERALL		
No anxiety	16.2	14.9-17.7	1.0	
0-3	13.7	7.6-23.4	0.82	0.567
4-10	16.9	11.3-24.6	1.05	0.837
10+	26.5	21.0-32.9	1.86	<0.001
		Currently 35 or younger		
No anxiety	4.8	4.8-6.1	1.0	
0-3	3.7	1.0-12.6	0.77	0.697
4-10	6.3	3.0-13.1	1.25	0.488
10+	11.8	6.0-21.9	2.66	0.008
		Currently older than 35 years		
No anxiety	29.8	27.1-32.7	1.0	
0-3	29.4	15.7-48.3	0.98	0.963
4-10	33.9	22.4-47.6	1.21	0.513
10+	30.2	27.5-32.9	1.16	0.400

Example: Of those who were under 35 at the time of the interview and had experience the onset of a depressive disorder 4-10 years earlier, 6.4% had a hypertension diagnosis.

5 DISCUSSION

5.1 Key Findings

This study provides evidence that a self-reported lifetime diagnosis of hypertension is 1.4-1.7 times more common among South Africans with anxiety disorders, depressive disorders and comorbid anxiety-depression compared to those without a mental disorder. The prevalence of self-reported hypertension was 23% in those with a lifetime anxiety disorder, 20% in those with a lifetime depressive disorder, and 22% in those with lifetime comorbid anxiety-depression. All of these proportions were significantly greater than the 15% reported by those without anxiety or depression.

In multivariate analysis that did not adjust for other chronic physical conditions, self-reported lifetime diagnosis of hypertension was positively associated with lifetime anxiety disorders (OR=1.38, 95% CI=1.07-1.79) but not with lifetime depressive disorders (OR=1.04, 95% CI=0.79-1.38) or lifetime comorbid anxiety-depression (OR=1.19, 95% CI=0.78-1.83). The results of the association between hypertension and a) anxiety, b) depression and c) comorbid anxiety-depression were largely analogous to findings in the literature. Anxiety and hypertension have a strong positive association that persists through adjustment in multivariate analysis, while the relation between depression and hypertension is nullified with adjustment for demographics and traumatic life events. Also, there is a positive but not significant association between comorbid anxiety-depression and hypertension due to the small number of participants with comorbid anxiety-depression.

Hypertension diagnosis without another chronic physical condition (hypertension only) was not associated with any of the mental health outcomes (anxiety, depression, and comorbid anxiety-depression) in crude analysis or multivariate models. For example, in crude analysis, 4% of those without lifetime anxiety or depression reported hypertension only compared to

3% of those with lifetime anxiety, 3% of those with lifetime depression and 2% of those with lifetime comorbid anxiety-depression (Table 6). When analysed as a combined variable, hypertension diagnosis with another chronic physical condition demonstrated strong crude associations with anxiety, depression and comorbid anxiety-depression. In multivariate models adjusting for demographics, SES, lifetime smoking and alcohol behaviour, substance use disorders and traumatic life events, hypertension diagnosis plus another chronic physical condition was associated with lifetime anxiety (OR=1.92), depression (OR=1.46), and comorbid anxiety-depression (OR=1.77) (Table 12). Thus, it appears that the overall association between hypertension diagnosis and mental disorders is accounted for largely by the presence of other chronic physical conditions that are comorbid with hypertension, and that hypertension diagnosis alone was not associated with an increased risk of anxiety and/or depression.

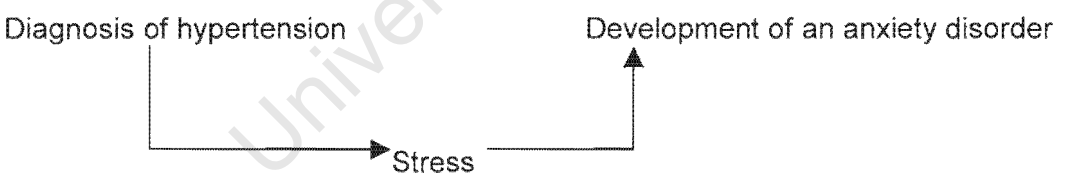
5.1.1 Anxiety

Anxiety showed a positive crude and adjusted association with hypertension diagnosis. Across the different anxiety disorders, hypertension had crude associations with lifetime panic disorder, GAD, agoraphobia and PTSD and with 12-month panic disorder and social phobia (Table 5). It therefore appears that the associations between hypertension diagnosis and anxiety disorders are driven by three of the five disorders. This result is similar to a case-control study from Europe, where there was a strong crude association between panic attacks and hypertension (p-value<0.01) but not with other anxiety disorders (p-value=0.24) (50). After adjustment for demographics, SES, lifetime smoking and alcohol behaviour, substance use disorders and traumatic life events, those with hypertension were 1.4 times more likely to have a lifetime anxiety disorder and 1.6 times more likely to have an anxiety disorder in the last 12-months compared to those without an anxiety disorder. This association is similar to the majority of the literature. For example, in an American cohort study those with *DSM-III*

anxiety disorders were 2.4 times more likely to have hypertension after adjustment for sex, substance abuse, and depression (23). A large cross-sectional study (n=1389) of older adults in France (aged 59-71) found a strong positive association between anxiety symptoms and elevated blood pressure. After adjustment for BMI and psychotropic drug use, men with the highest quartile of anxiety were 3.6 times more likely and women were 6.8 times more likely to be hypertensive (42).

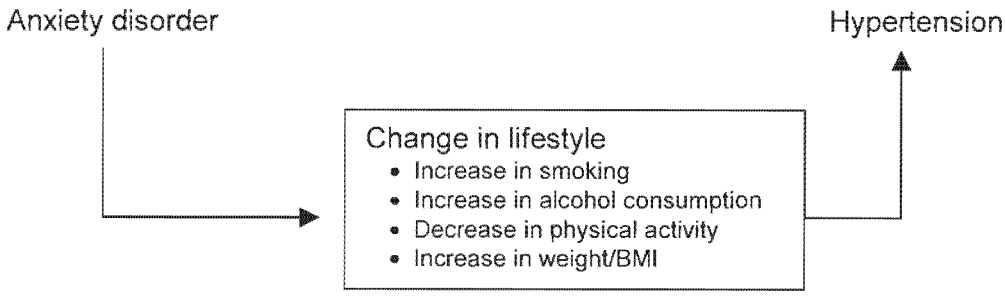
Our odds ratio of 1.4 may be lower than those found in previous studies as we adjusted for a larger number of potential cofounders. Our principle confounding factor appeared to be traumatic life events. The findings add to the previous evidence of an association between hypertension and anxiety. Furthermore, it provides evidence that the association exists in a developing country context, and that there is an association between self-reported lifetime diagnosis of hypertension and anxiety disorders. The stress associated with diagnosis of hypertension may lead to the development of anxiety (Figure 12) (25).

Figure 12: Potential causal pathway between diagnosis of hypertension and anxiety disorders



Alternatively, the onset of an anxiety disorder may indirectly increase risk for hypertension and other chronic physical conditions through negative changes in lifestyle such as increased smoking or obesity (Figure 13)(17, 25, 30, 67).

Figure 13: Potential causal pathway between anxiety disorders and hypertension



There is also potential for a bi-directional relationship, where the mechanisms in Figures 12 & 13 occur simultaneously. This is discussed in detail below within the section on temporality (Section 5.4).

5.1.2 Depression

Depressive disorders demonstrated a positive crude association (Lifetime OR=1.4, 95% CI=1.1-1.8) with hypertension diagnosis that did not persist in multivariate analysis when adjustment was made for demographics and traumatic life events. Major depression, both lifetime and 12-month, had strong crude associations with hypertension diagnosis whereas minor depression, both lifetime and 12-month, showed no association with hypertension diagnosis (Table 5). Therefore, it appears that only when depression is relatively severe is there an association with hypertension diagnosis.

These results are similar to the majority of the literature which suggests no association, or a crude association that does not persist in multivariate analysis between hypertension and depressive disorders. A large cohort in the United States found depressive symptoms to be crudely associated with age-adjusted incidence hypertension (28). However, subsequent adjustments for body mass index, smoking and alcohol behaviour, leisure time physical activity, job security and employment, education and race attenuated the relationship.

Previous research suggests that depressive symptoms may be associated with hypertension but not with *DSM-IV* depression (31).

Our results provide further evidence that after appropriate adjustment, *DSM-IV* depression is not associated with hypertension. Furthermore, it provides evidence that in a developing country context there is no association between self-reported lifetime diagnosis of hypertension and depressive disorders. Potentially, the diagnosis of hypertension on its own is not sufficient to increase the risk of development of hypertension. Only when the diagnosis of hypertension is accompanied by another chronic physical condition, is the stress significant enough to increase the likelihood of depression (Figure 14).

Figure 14: Potential causal pathway between diagnosis of hypertension, another chronic physical condition and depression

5.1.3 Comorbid Anxiety-Depression

There was a positive crude association between hypertension diagnosis and comorbid anxiety-depression (Lifetime OR=2.4, 95% CI=1.2-5.1). Furthermore, after adjustment for demographics, SES, lifetime smoking and alcohol behaviour, substance use disorders, and traumatic life events, those with a hypertension diagnosis and other chronic physical condition were 1.77 times more likely to have lifetime comorbid anxiety-depression. The association between comorbid anxiety-depression and hypertension appears to be largely a combination of the association that hypertension had with non-comorbid anxiety and non-comorbid depression. While it is has been hypothesized that comorbid anxiety-depression is more severe than non-comorbid anxiety and non-comorbid depression, there was no evidence of this from the findings (16, 18, 20). The amount of comorbidity with other chronic physical

conditions was largely the same between those with comorbid anxiety-depression and those with non-comorbid anxiety or depression. These findings are similar to those from Scott et al where those with comorbid anxiety-depression were no more likely to report a hypertension diagnosis than those with non-comorbid anxiety or depression (16).

Little evidence exists on the associations with comorbid anxiety-depression. Therefore, our results provide novel insight into the severity of comorbid anxiety-depression. In our study, the association with hypertension and another chronic physical condition was attenuated but still significant after adjustment for traumatic life events (Table 14). Therefore, traumatic life events were a partial confounder of the association. However, failure to show an adjusted association between hypertension and comorbid anxiety-depression may be the result of a lack of statistical power as only 67 people had comorbid anxiety-depression.

5.2 Other Findings

5.2.1 Lifetime and 12-month experience of *DSM-IV* disorders

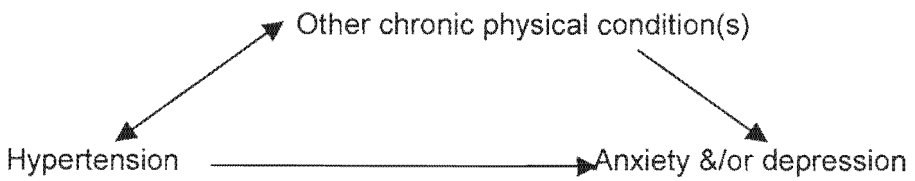
There were only very minor differences between the associations of hypertension diagnosis and mental disorders for lifetime and 12-months. Therefore, there does not appear to be any difference in the association with hypertension and common mental disorders experienced in the last 12-months versus during the lifetime in the South African context.

5.2.2 Chronic physical conditions and mental disorders

These results show novel evidence that hypertension in the absence of another chronic physical condition is not associated with anxiety, depression or comorbid anxiety-depression. This study is the first to examine the hypertension-mental health relationship with appropriate adjustment for other chronic physical conditions. More than three quarters of those with a diagnosis of hypertension had another chronic physical condition (79%) and other chronic

physical conditions had a strong crude association with anxiety, depression and comorbid anxiety-depression. Because hypertension on its own was not associated with any of the mental disorders, it appears that chronic physical conditions are a complete confounder in the hypertension and anxiety/depression relationship (Figure 15).

Figure 15: Other chronic physical conditions as a confounder



5.2.3 Traumatic life events

Traumatic life events showed strong associations with hypertension, anxiety, depression and comorbid anxiety-depression. Furthermore, adding traumatic life events to multivariate models always attenuated the relationship between hypertension and the mental health outcome. In some cases, traumatic life events only decreased the association between hypertension and mental health, and in other cases nullified the association. Traumatic life events may be a confounder in the hypertension-mental disorder relationship. Because exposure to a traumatic life event is not caused by hypertension or a mental disorder, it is said to not be in the causal pathway between hypertension and mental disorders. Therefore, exposure to a traumatic life event meets the definition of a confounder; it is associated with both hypertension and the mental disorders and is not in the causal pathway. The stress as a result of traumatic life event may be a shared risk factor of both anxiety and/or depression and hypertension (52). Stress has been implicated in the aetiology of both hypertension and mental health outcomes. Therefore, the attenuations observed by adjusting for traumatic life events contribute to evidence that stress is a shared risk factor for both anxiety and/or depression and hypertension. However, the relationships between anxiety and/or depression and hypertension persist after adjustment and therefore the relationship cannot entirely be

explained by stressful life events and chronic strain. Therefore, traumatic life events are only a partial confounder in the relationship between hypertension and mental disorders. These results add to the findings of Reiff et al, where after adjustment for age, sex, and other lifestyle factors, all five stressor variables were significant predictors of measured hypertension but none were significant predictors of self-reported hypertension (52).

5.2.4 Age

Age was not associated with mental disorders in any of the models. However, in models that predicted hypertension, age was very strongly associated with hypertension (p-values <0.001) (Table 14). Hypertension is thought to increase with age in developing countries, and therefore prevalence of hypertension is commonly reported for different age strata. However, in isolated or non-westernized populations hypertension may not increase as a function of age (11). Evidence from this study brings contradictory evidence to this theory as age was strongly associated with hypertension in a largely non-westernized population. However, it supports the 1998 SADHS where both mean systolic and diastolic blood pressure increased with age (2).

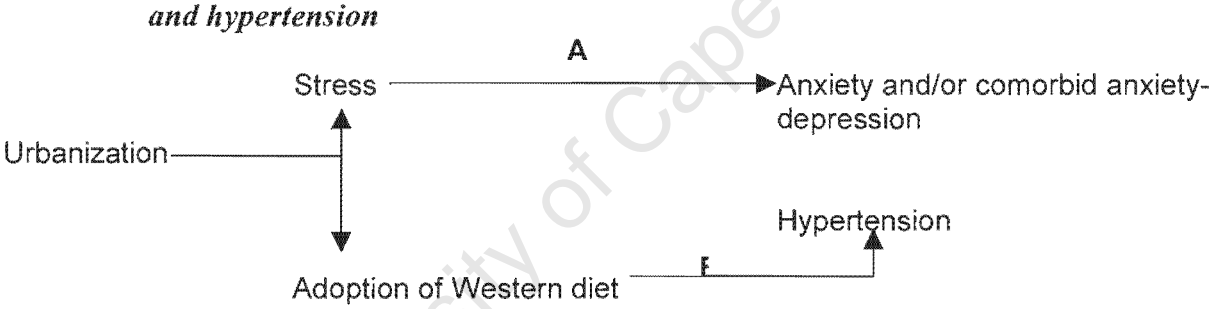
5.2.5 Sex

Females were at increased risk for anxiety, depression, and comorbid anxiety-depression in all of the crude and adjusted models. A large body of mental health research highlights that the traditional role of women places exposes them to greater stress and disempowers them to change their environment (7). Furthermore, domestic and sexual violence contribute significantly to the burden of depression and anxiety in women. South Africa has exceptionally high levels of violence towards women and this is likely to impact the high prevalence of anxiety and depressive disorders in females and may therefore make women more at risk for hypertension.

5.2.6 Location

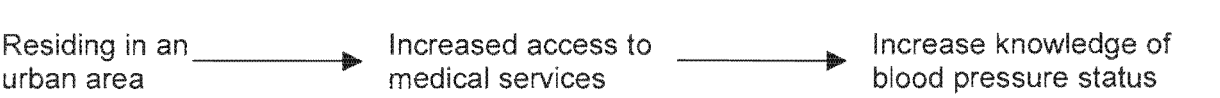
Residing in an urban area was an independent predictor of anxiety and comorbid anxiety-depression in the final multivariate models. None of the other papers reviewed adjusted for location of residence. South Africa has experienced large scale urbanization in recent decades, and the associated strain with this transition may be responsible for the association between urban location and anxiety and comorbid anxiety-depression (Figure 16, pathway A). Along with urbanization comes a major dietary shift towards high fat, energy dense foods. The adoption of this western diet is a risk factor for hypertension and therefore may explain some of the association between urban living and increased prevalence of hypertension (Figure 16, pathway B).

Figure 16: Potential causal mechanism(s) for urbanization and anxiety and/or depression and hypertension



Another potential reason for the higher prevalence of self-reported hypertension in those residing in urban areas may be the relationship between location of residence and access to medical services. Urban areas have increased access to medical services and resultantly those residing in urban areas may have more knowledge regarding their blood pressure (Figure 17).

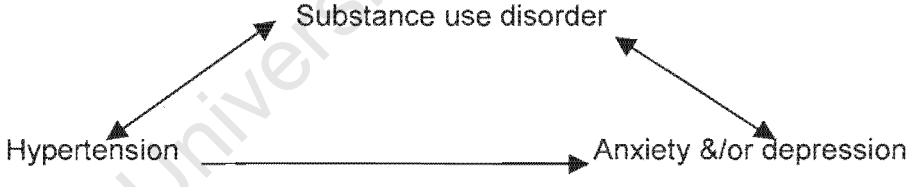
Figure 17: Role of access to services and location (urban/rural) in hypertension diagnosis



5.2.7 Substance Use Disorders

Substance use disorders were a strong independent predictor of mental health outcomes in all final models where hypertension diagnosis was modelled with other chronic physical conditions (Table 12). The association ranged from an odds ratio of 1.85 in those with lifetime comorbid anxiety-depression, to 1.88 in those with lifetime depression and 2.10 in those with lifetime anxiety disorders. However, while including substance use disorders in the models did decrease the association between hypertension diagnosis and mental disorders, the associations remained significant. This strong positive association is further evidence of mental comorbidity among substance use disorder and other mental disorders (7). Substance use disorders were therefore partial confounders in the relationship between hypertension diagnosis and mental disorders (Figure 18). The directionality of this relationship is not attainable from this cross-sectional database, and therefore substance use may increase with anxiety and/or depression, or may increase the likelihood of having anxiety and/or depression.

Figure 18: Substance use disorders as a potential confounder



5.2.8 Race

There were no significant associations between race and depression or comorbid anxiety-depression. In some of the 12-month models for depression, Indians/Asians were more likely to have depression but this association is likely spurious and due to chance. However, there were significant differences in the odds of anxiety disorders in certain race groups. Compared to Blacks, Whites and Coloureds had significantly lower odds of lifetime anxiety disorders after adjusting for demographics, socioeconomics, alcohol use, smoking, substance use

disorders and traumatic life events. Furthermore, when stratified by sex, race was not significantly associated with anxiety disorders in women. However, when the analysis was limited to males, White, Coloured, and Indian/Asian people had decreased odds of anxiety disorders compared to Black people. All of the multivariate models were rerun restricting to Blacks only. In none of these models were the results notably different to those models for the total population. This evidence of limited differencs in risk when stratified by race groups is contradictory to a large body of evidence from the United States (27, 54, 55). However, race is context specific and within South African, race was only associated with differences in the prevalence of lifetime anxiety disorders among males.

5.3 Strengths & Limitations

There are several notable limitations to these results. The cross-sectional design limits the ability to ascertain temporality between hypertension diagnosis and mental health outcomes. There are no data available on the date of hypertension diagnosis and therefore it is unclear whether or not the mental disorder preceded or followed the hypertension diagnosis. Furthermore, because in cross-sectional study design information is only collected from one period in time, it is bias towards conditions of a longer duration which are generally less severe. A detailed explanation of the strengths and limitations is provided below.

The study sample is nationally representative which gives it strong generalisability to the country and meaningful insight into the burden of hypertension and mental health in the country. Furthermore, with the exception of one study from Zimbabwe (47), this is the first large scale study of the association in an African context. It is only other study to examine the association between hypertension and mental health in a developing country.

The use of self-reported lifetime diagnosis of hypertension as the hypertension measure requires careful consideration. Self-reported hypertension is generally underreported (69). The prevalence of self-reported hypertension from this data was 17%. This is significantly less the prevalence of 21% reported by the 1998 SADHS from hypertension measured at the time of administering the questionnaire (6). The 1998 SADHS also reported self-reported hypertension. Women were more than twice as likely to report a hypertension diagnosis compared to men, and those in urban areas were more likely to know their hypertension status compared to those in rural areas (2). 19% of women reported ever being told they had hypertension, compared to only 8% of men.[3] Similarly, in this data 22% of women and only 10% of men reported a hypertension diagnosis.

However, self-reported hypertension may be a strength in that it represents a meaningful measure of the construction of illness. Because hypertension is asymptomatic, the self recognition of the condition may have important implications and associations. A cross-sectional study in the United States found no association between measured hypertension and depression after controlling for sociodemographics, stressors, and lifestyle factors (OR=0.85, 95% CI=0.35-2.09). Self-reported hypertension was strongly associated with depression after adjustment for the same factors (OR=3.95, 95%CI=1.51-10.35) (52). Therefore, self-reported hypertension may manifest and affect mental health outcomes differently than just the physiological pathways that link hypertension and mental health.

Mental health was assessed using the CIDI 3.0, an instrument designed in the context of developing countries. A significant body of literature is available on the cross-cultural challenges in measuring mental health. The literature highlights two primary issues; one on the linguistic issues regarding comprehension and understanding of mental health constructs and one of the socio-cultural nature of mental health and how the symptoms may manifest

[3] The prevalence of self-reported hypertension is reported twice in the 1998 SADHS report, both in Chapters 10 and 12. The prevalence by men and women is different between these two chapters. For the purpose of this study, the prevalences reported by Chapter 10 were used.

differently in different societies (70-71). As an example, it has been recognized that depression for black Africans may present with different linguistic phrases and the symptoms may both occur in different places and in different ways to those of Western culture (70). South Africa is a heterogeneous society, with significant diversity in cultures. The questionnaire was translated into six different languages and nationally-representative and therefore conducted in the many different contexts. The CIDI 3.0 has not been validated for South Africa, with research on the concordance of the CIDI compared to standardized clinical interviews for *DSM-IV* diagnosis (SCID) done only in France, Italy, Spain and the United States. The results show the agreement to be good, with CIDI 12-month prevalences generally conservative relative to SCID (72). There is potential for this measurement to introduce bias to the results, both through random and systematic misclassification. Random misclassification may have happened if the misclassification of mental disorders occurred to the same degree among those with and without hypertension diagnosis. There is also the potential for systematic misclassification, whereby those people with a certain cultural background were more or less likely to be classified with a mental disorder compared to those from another cultural background. For example, the CIDI 3.0 may be more valid for the white, European South African population as this population is the most similar to the context in which the CIDI 3.0 has been validated.

Random misclassification results in an underestimation of the true association. If random misclassification occurred in the diagnosis of anxiety disorders, the real association would be stronger than the observed the observed positive association between anxiety disorders and hypertension diagnosis. The association between depressive disorders and hypertension, and comorbid anxiety-depression and hypertension was not statistically significant. Potentially, there are associations and these were attenuated due to random misclassification. To investigate the potential for systematic bias, it is important to look at the differences in association when stratified by cultural groups. In this study, race is used as a crude measure

of culture, representing language and ethnicity. When the multivariate analyses were rerun restricting to Blacks only, there were no significant differences observed in the associations between hypertension diagnosis and mental disorders. Furthermore, previous analysis on the SASH data revealed no significant difference between the prevalence of anxiety disorders (p-value=0.38) or major depression (p-value=0.78) when stratified by the four racial groups (9). Therefore, while this is potential for bias and the CIDI 3.0 has not be validated within the South African context, it does not appear that bias is driving the associations observed between hypertension diagnosis and mental disorders.

A strength of the dataset was information was available on a number of potential confounders that have not been accounted for in previous studies of this association. We were able to adjust for demographics and socioeconomics, as well as lifestyle risk factors (smoking and alcohol use) and substance use disorders. Furthermore, we were able to control for traumatic life events and subsequently provide strong evidence that the stress from traumatic life events does not fully explain the hypertension and anxiety association. We also had information on a large number of chronic physical conditions, both conditions in the past 12-months and lifetime diagnoses from health care professionals. Only three of previous studies had adjusted for other chronic physical conditions, one for glucose intolerance, one for type 2 diabetes, stroke and coronary heart disease, and one for MI, angina, stroke, hypercholesterolemia and type 2 diabetes (29, 42, 46). Adjustment for other chronic physical conditions proved highly important, demonstrating that hypertension on its own has no association with anxiety, depression or comorbid anxiety-depression in crude or adjusted analyses.

An important limitation of our study was that we did not have some of the other recognized risk factors for hypertension including family history of hypertension, body mass index or obesity, and physical inactivity. Family history of hypertension is a common and strong risk

factor for hypertension (55) and was an independent predictor of hypertension in four studies (27, 30, 47, 48), and not an independent predictor in one other study (41). There is also consistent evidence of a relationship between body mass index (BMI) and hypertension. Five studies found BMI to be an independent risk factor for hypertension (13, 27, 28, 30, 52) and in an American cohort study BMI was a risk factor for both anxiety and depression (43). Physical inactivity is another lifestyle factor which has strong evidence of an association with hypertension. In an American cohort study physical inactivity was an independent predictor of hypertension (27) while in two other studies, the relationship between physical inactivity and hypertension was insignificant after adjustment for other confounders (13, 30).

5.4 Temporality

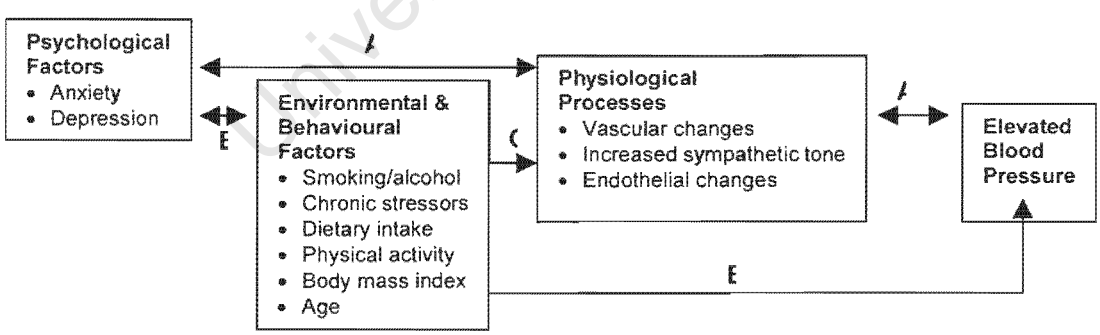
Determining the temporality of the hypertension and anxiety and/or depression relationship is a limitation. Because there was no measure of the time when hypertension was diagnosed, this was quite difficult. Tables 17 and 18 present the prevalence of hypertension based on time since onset of anxiety and depression, and suggest that those who have a recent onset (within the last 10 years) have a similar prevalence of hypertension compared to those without anxiety or depression. They further suggest that those with a long time since onset (10 years or more) have a significantly higher prevalence of hypertension compared to those without anxiety or depression. Therefore, it appears that within the South African context, the relationship between hypertension and mental disorders is bi-directional. In other words, hypertension diagnosis may increase the odds of anxiety and/or depression and mental disorders, may increase the odds of hypertension.

This bi-directional association suggests that multiple mechanisms, both pathophysiological and behavioural explain the relationship between hypertension and anxiety (27, 42). Anxiety and depression may increase the odds of development of hypertension through either a)

changes in physiology and/or b) negative changes in lifestyle. There is substantial evidence that those with anxiety and/or depression have poor regulation of adrenergic activity, an increase in plasma norepinephrine, and increased arousal and mobilization of energy stores making the heart more reactive (13, 27, 30, 31, 42, 67, 68). These physiological changes will increase the odds of elevated blood pressure, and elevated blood pressure will also therefore increase the odds of anxiety and depression through these same physiological changes (Figure 19, pathway A). Furthermore, having an anxiety or depressive disorder may negatively impact behaviour, and this behaviour may result in an unhealthy lifestyle that increases the risk for development of hypertension (Figure 19, pathway B).

Also, changes in environmental and behavioural factors may increase the odds of both mental disorders and elevated blood pressure. Moreover, negative lifestyle behaviours will impact the physiological processes that increase the odds of both mental disorders and hypertension (Figure 19, pathway C).

Figure 19: Possible bi-directional relationship between anxiety and depression and elevated blood pressure*



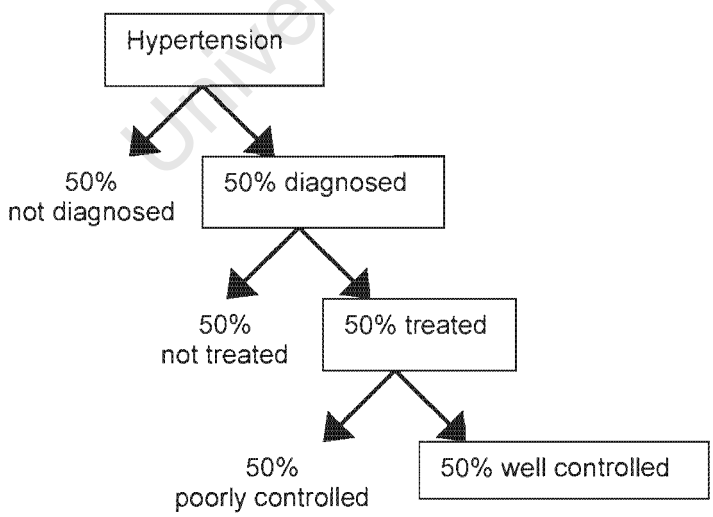
*Adapted from Rutledge et al 2003

5.5 Implications for policy and future research

The high prevalence of hypertension, anxiety, depression and chronic physical conditions have large implications for potential changes to national health policy. While the results of

this study alone cannot provide sufficient evidence to motivate for large-scale change, they do highlight the significance of physical-mental comorbidity in a developing country context. Because hypertension was only associated with anxiety and depression when present with another chronic physical condition, there is evidence to support increased efforts for the early identification and adequate management of hypertension. If blood pressure is screened regularly and hypertension properly controlled, a proportion of subsequent chronic physical conditions where hypertension is a risk factor will be decreased. Consequently, hypertension will not be a risk for development of anxiety and depressive disorders. Hypertension is known to follow "the rule of halves" whereby only 50% of those with hypertension are diagnosed, only 50% of those are treated, and of those only 50% have their hypertension adequately controlled (Figure 20) (73). Potentially, "the rule of halves" could by explained by the high proportion prevalence of mental disorders among those with hypertension. Those with mental disorders may be less likely to adhere to medication and therefore need increased support to ensure treatment and control of hypertension.

Figure 20: Hypertension and "the rule of halves"*



*Taken from Bannan et al, 1981

The results of this study also provide rationale for government and policy makers to begin investigating the feasibility of integrating mental health screening into the primary care setting. Various systems of combined screening for both hypertension and other chronic disease risk factors along side screening for mental health would provide an increased quality of care. Furthermore, due to the high prevalence of traumatic life events and the strong association between traumatic life events and both physical and mental illness, substantial efforts should be made to increase the capacity of the health sector to provide support following such events. Making proper counselling services available would be a proactive approach to preventing some of the subsequent chronic disease and mental illness. Specific policies aimed at women also need to be put into place as women who were very much at an increased risk for development of depression and anxiety and reported a much higher prevalence of hypertension. Conversely, men were far less likely to report hypertension despite having a similar prevalence (6). This suggests that it may be beneficial to target men with chronic disease screening and increase the level of knowledge regarding blood pressure especially among men. In recognition that those in urban areas were more likely to have negative mental health outcomes, the capacity at urban primary care facilities to deal with mental health should become a priority. Furthermore, to prevent the high prevalences of mental disorders and hypertension in urban areas, programmes targeting those new to urban area to adjust with the shift in lifestyle may be beneficial in reducing the association risks of urbanization.

While there has been a long interest in the psychosocial factors underlying hypertension, there is a scarcity of this research in the context of developing countries. Furthermore, the impact of mental health in developing countries is largely neglected, and there is increased support to acknowledge that the high level of suffering due to living in impoverished settings is no longer acceptable (26). Further research should strive to use both self-reported and measured

hypertension, as well as *DSM* diagnosis of anxiety disorders and depression. Furthermore, all studies that are interested in the associations between hypertension and anxiety or depression, should measure both anxiety and depression and specifically investigate the associations of hypertension with comorbid anxiety-depression. While studies looking at incident hypertension or incident mental disorders may not be cost-effective, efforts should be made to investigate both the directionality of the association, and the mechanism. Further research should also measure other chronic physical conditions and traumatic life events, with both being potentially complete confounders of the hypertension and mental disorders association.

5.6 Conclusion

The results of this study demonstrate that there is a high degree of comorbidity between chronic physical conditions, including hypertension, and mental disorders in South Africa. Hypertension was not associated with any mental health outcome after adjusting for participant demographics, socioeconomic status, smoking and alcohol use, substance use disorders, traumatic life events, and other chronic physical conditions. From these data it appears that chronic physical conditions are a complete confounder of the hypertension and anxiety/depressive disorder relationship. In addition to other chronic physical conditions confounding the association, traumatic life events are also likely to play a confounding role in the hypertension-mental health association. The data are less conclusive about the temporality of this association, and there are a number of different possible mechanisms by which hypertension diagnosis and mental disorders may be related.

Further investigations into the temporality and the role of comorbid conditions in the hypertension and anxiety/depressive disorder relationship should remain a priority. Increased efforts should be made for early detection and control of hypertension as this can prevent development of subsequent chronic physical conditions and therefore prevent a proportion of anxiety and depressive disorders. Due to the high levels of physical-mental comorbidity,

screening of mental disorders requires greater attention alongside of screening for chronic physical conditions.

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Appendix A Summary of literature on the association between hypertension and anxiety disorders

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Anxiety	Results for hypertension-anxiety association	Notes (lack of adjustment, etc)
Coelho, 1989 (39)	Case-control	Portugal	N=304 (equal cases and controls), controls also from general practice	Blood pressure measured (160/95)	Zung Anxiety Scale (SAS)	Those with hypertension had a significantly higher SAS ($p<0.05$)	No adjustment
Davies, 1999 (49)	Case-control	UK	N=602	a) measured hypertension of 160/90 b) antihypertensive treatment	Self-administered : a) Questionnaire on panic attacks and disorders b) Hospital anxiety and depression scale	Anxiety scores were significantly higher in those with hypertension	The reported diagnosis of hypertension antedated the onset of panic attacks in a large majority of patients ($p=0.01$)
Dorn, 2006 (41)	Cohort	Netherlands	N=499 cases (parents of fire victims) N=1746 controls (parents, community controls) 4-year follow-up	a) diagnosed by family practitioner b) received at least one prescription for antihypertensive medication c) had 3+ measurements of greater than 140/90	Exposure : Parents of adolescents who were in a fire	Incidence hypertension 1.48 times higher (95% confidence interval (CI): 1.09, 2.02) in parents of fire victims Bereaved (odds ratio (OR) 2.42, 0.90, 6.55), parents of victims with burns (OR 1.43, 0.97, 2.11) parents of victims without burns (OR 1.44, 0.92, 2.26).	Adjustment for the covariates age, sex, insurance type, history of chronic disease, number of contacts with the family practitioner during the postfire follow-up period, family practice, and single parenthood.

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Anxiety	Results for hypertension-anxiety association	Notes (lack of adjustment, etc)
Harter, 2003 (23)	Cohort	USA	N=262 (n=169anxiety disorder from treatment setting, n=93 controls from random digit dialling)	Interview question regarding lifetime illnesses	Schedule for Affective Disorders and Schizophrenia (SADS) and Family History-Research Diagnosis criteria (FH-RDC) – modified to obtain *DSM-III-R* Add to lit review	2.12(0.99-4.55) Adjusted for sex and substance use disorder 2.35 (1.06-5.17) Adjusted for sex, substance use disorder and depression	Association in both males and females
Jonas, 1997 [abstract] (29)	Cohort	USA	N=2992	a) treated hypertension – prescription of antihypertensive medication b) incidence hypertension= 160/95 mm Hg or prescription of antihypertensive medication	Unknown	Whites aged 45 to 64 years: anxiety ([RR], 1.82; 1.30-2.53) Treated hypertension-anxiety (RR, 2.36; 1.73-3.23) Blacks 25 to 64 Anxiety (RR, 2.74; 1.35-5.53) Treated hypertension Anxiety (RR, 3.24; 1.59-6.61) Whites 25 to 44 Intermediate anxiety (RR, 1.62; 1.18-2.22	Adjusted for age; sex; education; cigarette smoking; body mass index; alcohol use; history of diabetes, stroke, or coronary heart disease; and baseline systolic blood pressure Abstract only
Jones-Webb, 1996 (44)	Cross-sectional	USA	N=4352 adults	Measured	20-item Spielberger Trait Anxiety Scale	No association with anxiety symptoms in men or women	Smoking status, BMI, health status and demographic variables
Kadam 2005 (45)	Case-control	UK	Anxiety n=13,421 Controls n=15,000 (randomly selected	Defined on the basis of a consultation for hypertension	Defined on the basis of a consultation for "anxiety" as an example of psychological distress	OR=0.9, 6.7% compared to 7.5% in controls	Adjusted for age, sex, and social class Those with anxiety 4.1 times more likely to have a depressive disorder

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Anxiety	Results for hypertension-anxiety association	Notes (lack of adjustment, etc)
Lowe, 2004 (50)	Case-control	Germany, Switzerland and Austria	Pulmonary hypertension n=164 Primary care n=164	Pulmonary hypertension according to the 1998 World Symposium on PH	Patient Health Questionnaire which gives algorithms for *DSM-IV-TR*	Panic disorder p=0.003 Panic attacks p=0.009 Other anxiety disorders p=0.24	No adjustment
Markovitz, 1991 (48)	Cohort	USA	N=468 women, 3 years	140/90 measured	Framingham Tension Scores	Change in anxiety score independently predicted an increase in SBP(<0.01)	Adjusted for level of education, smoking status, activity level, sodium and calcium intake, sibling history of hypertension, alcohol consumption increases in BMI
Markovitz, 1993 [abstract] (46)	Cohort	UK	N=1123	a) taking antihypertensive medication b) blood pressure higher than 160/95 mm	Not reported, presume Framingham Tension scores	Crude association in men between baseline anxiety and incident hypertension Anxiety remained an independent predictor of hypertension in middle-aged men (p = .02). Only middle-aged men with very high levels of anxiety were at increased risk (relative risk, 2.19; 95% CI= 1.22-3.94)	Adjusted for biological predictors including heart rate, weight, age, hematocrit, alcohol intake, smoking, education, glucose intolerance. No crude or adjusted association in women
Paterniti, 1999 (42)	Cross sectional	France	N=1389, age 59-71 (those on anti-hypertensive drugs excluded)	Measured	Spielberger Inventory Trait, 20-item	Crude association with depressive symptoms in men, not in women Multivariate analysis shows that the risk of hypertension increases with anxiety in both men and women	BMI and psychotropic drug use, presence of chronic disease, alcohol consumption (OR's including chronic disease are not presented)

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Anxiety	Results for hypertension-anxiety association	Notes (lack of adjustment, etc)
Raikkonen, 2001 (30)	Cohort	USA	N=541 Women	a) self reported use of anti-hypertensive medication b) 140/90 on 2 consecutive exams	a)Spielberger Trait Anxiety Questionnaire b)Framingham Tension Scale c) Social Anxiety Scale	No crude associations Framingham tension scale remained significant ($p<0.03$) but social anxiety was not significant	SBP, BMI, parental history of hypertension,
Scott, 2006 (19)	Cross-sectional	New Zealand	N=12,992	Self-reported, "Have you ever been told by a doctor"	WMH-CIDI	Age adjusted prevalence was higher in those with an anxiety disorder ($p<0.01$)	No other adjustments, relationship was not significant when stratified by sex
Shinn, 2001 (43)	Cohort	USA	N=433 adults	140/90 (measured)	GWB-A	No crude association Anxiety did not predict hypertension	Adjustment for baseline SBP, baseline BMI, age at entry, sex, parental history of hypertension, antidepression/ anxiolytic use
Somonva, 1995 (47)	Cohort	Zimbabwe	N=528, students	Measured, 160/95	Framingham tension scale (7-items)	Anxiety a significant predictor of hypertension in Blacks but not whites	Sex, change in BMI, change in pulse rate, initial SBP, smoking status, alcohol consumption, family history of hypertension, hostility and family instability
Tie-Min, 2006 (40)	Cross-sectional	China	N=891 patients with hypertension	Diagnosis from a doctor and then measured and classified into WHO grades I, II and III	Zung self rated anxiety scale (SAS)	Higher in females ($p<0.001$) and patients with hypertension duration of more than 3 years ($p=0.01$and history of hospitalization for CVD ($p<0.001$)	Adjusted for age, sex, education, occupation, hypertensive drugs, severity

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Anxiety	Results for hypertension-anxiety association	Notes (lack of adjustment, etc)
Yan, 2003 (13)	Cohort	USA	N=3308, 18-30 year olds	Incidence hypertension (140/90) or antihypertensive medication	Spielberger Trait Anxiety Inventory (20 items)	No consistent patterns found for anxiety	Adjusted for age, education, BMI, physical activity, alcohol consumption and systolic BP, race and sex

Appendix B Summary of literature on the association between hypertension and depressive disorders

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Depression	Results for hypertension-depression association	Notes (lack of adjustment, etc)
Coelho, 1989 (39)	Case-control	Portugal	N=304 (equal cases and controls), controls also from general practice	Essential hypertension, severity less than WHO Class III (160/95)	Beck Depression Inventory (BDI)	Those with hypertension had higher BDI scores ($p<0.05$)	No adjustment
Davidson, 2000 (27)	Cohort	USA	N=3343	Measured 160/95 or antihypertensive medication	CES-D Scale	High levels of depression associated with a significant risk of hypertension incidence compared to low levels of depression (OR+2.1, 1.22-3.61) Medium to low (OR+1.78; 1.06-2.98)	Adjustment for age, resting systolic BP, PA, alcohol, parental history of hypertension, education, IDDM, heart disease, sex, and race Found in blacks alone, not in whites
Jonas, 1997 [abstract] (29)	Cohort	USA	N=2992	a) treated hypertension – prescription of antihypertensive medication b) incidence hypertension= 160/95 mm Hg or prescription of antihypertensive medication	Unknown	Whites 45 to 64: RR=1.80; (1.16-2.78) , Treated: RR=1.89(1.25-2.85) Blacks 25 to 64: RR=2.99 (1.41-6.33), Treated RR=2.92; 95% CI=1.37-6.22) Whites 25 to 44 Intermediate depression :RR= 1.60; (1.17-2.17)	Abstract only Adjusted for age; sex; education; cigarette smoking; body mass index; alcohol use; history of diabetes, stroke, or coronary heart disease; and baseline systolic blood pressure

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Depression	Results for hypertension-depression association	Notes (lack of adjustment, etc)
Jones-Webb, 1996 (44)	Cross-sectional	USA	N=4352 adults	Measured	CES-D	No association with depressive symptoms in men or women	Smoking status, BMI, health status and demographic variables
Levenstien, 2001 (28)	Cohort	USA (Cali)	N=2357 adults of a population sample	Self-reported prescribed antihypertensive medication in follow up	18-item Alameda County Student depression scale	Depressive symptoms had a significant age-adjusted association with hypertension, but not when adjusted leisure time PA	Adjusted for BMI, alcohol consumption, smoking status, and leisure time PA Significant association persisted in women but not men
Lowe, 2004 (50)	Case-control	Germany, Switzerland and Austria	Pulmonary hypertension n=164 Primary care n=164	Pulmonary hypertension according to the 1998 World Symposium on PH	Patient Health Questionnaire which gives algorithms for *DSM-IV-TR*	Major depression p=0.14 Other depression p=0.32	No adjustment
Paterniti, 1999 (42)	Cross sectional	France	N=1389, age 59-71 (those on anti-hypertensive drugs excluded)	Measured	CES-D 31 (French version)	Not association with depressive symptoms in crude analysis for men or women Multivariate analysis those with depressive symptoms less likely to be hypertensive	BMI and psychotropic drug use, presence of chronic disease, alcohol consumption (OR's including chronic disease are not presented)
Raikkonen, 2001 (30)	Cohort	USA	N=541 Women	a) self reported use of anti-hypertensive medication b) 140/90 on 2 consecutive exams	BDI	No crude association Not reported	BMI, parental history of hypertension,

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Depression	Results for hypertension-depression association	Notes (lack of adjustment, etc)
Reiff, 2001 (52)	Cross-sectional	USA (Harlem)	695 predominantly black adults	a) self report of ever having hypertension b) measured higher than 140/90 OR on antihypertensive medication	24-item scale based on the Diagnostic Interview Schedule	Depressive symptoms were associated with self-reported OR=3.95(1.51-10.35) but not measured hypertension OR=0.85 (0.35-2.09)	Adjusted for sociodemographic, stressors and lifestyle factors
Scherrer, 2003 (31)	Cohort	Vietnam	N=6903 male-male twins N=2731 in model	Have you ever been told by a doctor that you had hypertension or high blood pressure?	Via telephone administrated DIS3R – *DSM-III-R* criteria	Major depression and hypertension (OR=1.22), not significant and unadjusted	52% had major depression before hypertension, 60-88% had *DSM-III-R* depression before the onset of each heart disease phenotype
Scott, 2006 (19)	Cross-sectional	New Zealand	N=12,992	Self-reported, "Have you ever been told by a doctor"	WMH-CIDI	Age adjusted prevalence was not higher in those with a mood disorder	No other adjustments, relationship was not significant when stratified by sex
Shinn, 2001 (43)	Cohort	USA	N=433 adults	140/90 (measured)	a) GWB-D b) CES-D	No crude association Depression did not predict hypertension	Adjustment for baseline SBP, baseline BMI, age at entry, sex, parental history of hypertension, antidepression/ anxiolytic use
Wiehe, 2006 (51)	Cross-sectional	Brazil	N=1174 adults (90% of eligible population)	Blood pressure measured Hypertension = >140/90 (34.7%)	*DSM-IV* Criteria for depression 12.4%, 17.3% of women and 6.2% of men	Crude 0.96 (0.7-1.23) Adjusted 1.15 (0.75-1.76)	Adjusted for age, skin colour, education, BMI, alcohol consumption, PA, do not adjust for sex

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Depression	Results for hypertension-depression association	Notes (lack of adjustment, etc)
Yan, 2003 (13)	Cohort	USA	N=3308, 18-30 year olds	Incidence hypertension (140/90) or antihypertensive medication	CES-D (20 items)	No consistent patterns found for anxiety	Adjusted for age, education, BMI, physical activity, alcohol consumption and systolic BP, race and sex

Appendix C Summary of literature on the association between hypertension and comorbid anxiety-depression

Author, year	Study design	Setting	Study population	Measures: BP	Measures: Anxiety	Measures: Depression	Results for hypertension-comorbid anxiety-depression association	Notes (lack of adjustment, etc)
Jonas, 2000 (17)	Cohort	USA, NHANES	N=3310	Hypertension end points included 1) self-reported doctor diagnosis, 2) treated (prescription of antihypertensive medications), and 3) incident (blood pressure 160/95 mm Hg or treated) hypertension.	General Well-Being Schedule The Relaxed vs. Anxious scale (GWB-A)	General Well-Being Schedule Cheerful vs. Depressed scale (GWB-D)	Increased negative affect was associated with elevated risk for self-reported (RR=1.98, 95% CI 1.54-2.56), treated (OR=1.57, 95% CI=1.20-2.06), and incident hypertension (OR=1.98, 95% CI=1.47-2.68) at first follow-up.	Adjusted for baseline age, sex, race, education, smoking, alcohol use, diastolic and systolic blood pressure, body mass index, and change in body mass index
Scott, 2007 (16)	Cross sectional	17 countries	N=42, 249	Self reported, "In your lifetime, has a doctor ever told you"	WMH-CIDI	WMH-CIDI	Non-comorbid anxiety OR=1.5 (1.4, 1.8) , Non-comorbid depression= 1.7 (1.5, 1.9), comorbid anxiety-depression 1.8 (1.5, 2.1) Comorbid with reference group non-comorbid 1.0 (0.9, 1.2)	Adjustment for age and sex

Appendix D – *DSM-IV* Diagnostic criteria for panic disorder without agoraphobia (15)

A. Both (1) and (2):

(1). Recurrent unexpected Panic Attacks
(2). At least one of the attacks has been followed by 1 month (or more) of one (or more) of the following:

a. persistent concern about having additional attacks
b. worry about the implications of the attack or its consequences (e.g., losing control, having a heart attack, "going crazy")
c. a significant change in behavior related to the attacks

B. Absence of Agoraphobia

C. The Panic Attacks are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hyperthyroidism).

D. The Panic Attacks are not better accounted for by another mental disorder, such as Social Phobia (e.g., occurring on exposure to feared social situations), Specific Phobia (e.g., on exposure to a specific phobic situation), Obsessive-Compulsive Disorder (e.g., on exposure to dirt in someone with an obsession about contamination), Posttraumatic Stress Disorder (e.g., in response to stimuli associated with a severe stressor), or Separation Anxiety Disorder (e.g., in response to being away from home or close relatives).

DIAGNOSTIC CRITERIA FOR A PANIC ATTACK
Note: a Panic Attack is not a codable disorder.

A discrete period of intense fear or discomfort, in which four (or more) of the following symptoms developed abruptly and reached a peak within 10 minutes:

- palpitations, pounding heart, or accelerated heart rate
- sweating
- trembling or shaking
- sensations of shortness of breath or smothering
- feeling of choking
- chest pain or discomfort
- nausea or abdominal distress
- feeling dizzy, unsteady, lightheaded, or faint
- derealization (feelings of unreality) or depersonalization (being detached from oneself)
- fear of losing control or going crazy
- fear of dying
- paresthesias (numbing or tingling sensations)
- chills or hot flushes

Appendix E – *DSM-IV* Diagnostic criteria for Generalized Anxiety Disorder (15)

A. Excessive anxiety and worry (apprehensive expectation), occurring more days than not for at least 6 months, about a number of events or activities (such as work or school performance).

B. The person finds it difficult to control the worry.

C. The anxiety and worry are associated with three (or more) of the following six symptoms (with at least some symptoms present for more days than not for the past 6 months). Note: Only one item is required in children.

- restlessness or feeling keyed up or on edge
- being easily fatigued
- difficulty concentrating or mind going blank
- irritability
- muscle tension
- sleep disturbance (difficulty falling or staying asleep, or restless unsatisfying sleep)

D. The focus of the anxiety and worry is not confined to features of an Axis I disorder, e.g., the anxiety or worry is not about having a Panic Attack (as in a Panic Disorder), being embarrassed in public (as in Social Phobia), being contaminated (as in Obsessive-Compulsive Disorder), being away from home or close relatives (as in Separation Anxiety Disorder), gaining weight (as in Anorexia Nervosa), having multiple physical complaints (as in Somatization Disorder), or having a serious illness (as in Hypochondriasis), and the anxiety and worry do not occur exclusively during Posttraumatic Stress Disorder.

E. The anxiety, worry, or physical symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

F. The disturbance is not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hyperthyroidism) and does not occur exclusively during a Mood Disorder, a Psychotic Disorder, or a Pervasive Developmental Disorder.

Appendix F – *DSM-IV* Diagnostic criteria for Social Phobia (15)

A. A marked and persistent fear of one or more social and performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others. The individual fears that he or she will act in a way (or show anxiety symptoms) that will be humiliating or embarrassing. Note: In children, there must be evidence of the capacity for age-appropriate social relationships with familiar people and the anxiety must occur in peer settings, not just in interactions with adults.

B. Exposure to the feared social situation almost invariably provokes anxiety, which may take the form of a situationally bound or predisoposed Panic Attack. Note: In children, the anxiety may be expressed by crying, tantrums, freezing, or shrinking from social situations with unfamiliar people.

C. The person recognizes that the fear is excessive or unreasonable. Note: In children, this feature may be absent

D. The feared social or performance situation are avoided or else are endured with intense anxiety or distress

E. The avoidance, anxious anticipation, or distress in the feared social or performance situation(s) interferes significantly with the person's normal routine, occupational (academic) functioning, or social activities or relationships, or there is marked distress about having the phobia.

F. In individuals under age 18 years, the duration is at least 6 months

G. The fear or avoidance is not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition and is not better accounted for by another mental disorder (e.g., Panic Disorder With or Without Agoraphobia, Separation Anxiety Disorder, Body Dysmorphic Disorder, a Pervasive Developmental Disorder, or Schizoid Personality Disorder).

H. If a general medical condition or another mental disorder is present, the fear in Criterion A is unrelated to it, e.g., the fear is not of Stuttering, trembling in Parkinson's disease, or exhibiting abnormal eating behavior in Anorexia Nervosa or Bulimia Nervosa

Specify if:

Generalized: if the fears include most social situations (also consider the additional diagnosis of avoidant personality disorder).

Appendix G – *DSM-IV* Diagnostic criteria for Agoraphobia (15)

Note: Agoraphobia is not a codable disorder. Code the specific disorder in which the agoraphobia occurs (e.g. panic disorder with agoraphobia or agoraphobia without history of panic disorder).

A. Anxiety about being in places or situations from which escape might be difficult (or embarrassing) or in which help may not be available in the event of having an unexpected or situationally predisposed Panic Attack or panic-like symptoms. Agoraphobic fears typically involved characteristic clusters of situations that include being outside the home alone; being in a crowd or standing in a line; being on a bridge; and traveling in a bus, train or automobile.
   Note: consider the diagnosis of Specific Phobia if the avoidance is limited to one or only a few specific situations, or Social Phobia if the avoidance is limited to social situations.

B. The situations are avoided (e.g., travel is restricted) or else are endured with marked distress or anxiety about having a Panic Attack or panic-like symptoms, or require the presence of a companion.

C. The anxiety or phobic avoidance is not better accounted for by another mental disorder, such as Social Phobia (e.g., avoidance limited to social situations because of fear of embarrassment), Specific Phobia (e.g., avoidance limited to single situation like elevators), Obsessive-Compulsive Disorder (e.g., avoidance of dirt in someone with an obsession about contamination), Posttraumatic Stress Disorder (e.g., avoidance of stimuli associated with a severe stressor), or Separation Anxiety Disorder (e.g., avoidance of leaving home or relatives).

Appendix H – *DSM-IV* Diagnostic criteria for Posttraumatic stress disorder (15)

A. The person has been exposed to a traumatic event in which both of the following have been present:

(1) the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others (2) the person's response involved intense fear, helplessness, or horror. Note: In children, this may be expressed instead by disorganized or agitated behavior.

B. The traumatic event is persistently reexperienced in one (or more) of the following ways:

(1) recurrent and intrusive distressing recollections of the event, including images, thoughts, or perceptions. Note: In young children, repetitive play may occur in which themes or aspects of the trauma are expressed.

(2) recurrent distressing dreams of the event. Note: In children, there may be frightening dreams without recognizable content.

(3) acting or feeling as if the traumatic event were recurring (includes a sense of reliving the experience, illusions, hallucinations, and dissociative flashback episodes, including those that occur upon awakening or when intoxicated). Note: In young children, trauma-specific reenactment may occur.

(4) intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

(5) physiological reactivity on exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

C. Persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness (not present before the trauma), as indicated by three (or more) of the following:

(1) efforts to avoid thoughts, feelings, or conversations associated with the trauma

(2) efforts to avoid activities, places, or people that arouse recollections of the trauma

(3) inability to recall an important aspect of the trauma

(4) markedly diminished interest or participation in significant activities

(5) feeling of detachment or estrangement from others

(6) restricted range of affect (e.g., unable to have loving feelings)

(7) sense of a foreshortened future (e.g., does not expect to have a career, marriage, children, or a normal life span)

D. Persistent symptoms of increased arousal (not present before the trauma), as indicated by two (or more) of the following:

(1) difficulty falling or staying asleep
(2) irritability or outbursts of anger
(3) difficulty concentrating
(4) hypervigilance
(5) exaggerated startle response

E. Duration of the disturbance (symptoms in Criteria B, C, and D) is more than one month.

F. The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Specify if:
Acute: if duration of symptoms is less than 3 months
Chronic: if duration of symptoms is 3 months or more

Specify if:
With Delayed Onset: if onset of symptoms is at least 6 months after the stressor

Appendix I – *DSM-IV* Diagnostic criteria for Major depressive disorder (15)

Single Episode

A. Presence of a single Major Depressive Episode

B. The Major Depressive Episode is not better accounted for by Schizoaffective Disorder and is not superimposed on Schizophrenia, Schizophreniform Disorder, Delusional Disorder, or Psychotic Disorder Not Otherwise Specified.

C. There has never been a Manic Episode, a Mixed Episode, or a Hypomanic Episode. Note: This exclusion does not apply if all the manic-like, mixed-like, or hypomanic-like episodes are substance or treatment induced or are due to the direct physiological effects of a general medical condition.

Recurrent

A. Presence of two or more Major Depressive Episodes.
Note: To be considered separate episodes, there must be an interval of at least 2 consecutive months in which criteria are not met for a Major Depressive Episode.

B. The Major Depressive Episodes are not better accounted for by Schizoaffective Disorder and are not superimposed on Schizophrenia, Schizophreniform Disorder, Delusional Disorder, or Psychotic Disorder Not Otherwise Specified.

C. There has never been a Manic Episode, a Mixed Episode, or a Hypomanic Episode. Note: This exclusion does not apply if all the manic-like, mixed-like, or hypomanic-like episodes are substance or treatment induced or are due to the direct physiological effects or a general medical condition.

Specify (for current or most recent episode):
Severity/Psychotic/Remission Specifiers
Chronic
With Catatonic Features
With Atypical Features
With Postpartum Onset

Specify
Longitudinal Course Specifiers (With and Without Interepisode Recovery)
With Seasonal Pattern

DSM IV Major Depressive Episode

A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.
Note: Do note include symptoms that are clearly due to a general medical condition, or mood-incongruent delusions or hallucinations.

(1) depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful). Note: In children and adolescents, can be irritable mood.

(2) markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others)

(3) significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. Note: In children, consider failure to make expected weight gains.
(4) insomnia or hypersomnia nearly every day

(5) psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down)

(6) fatigue or loss of energy nearly every day

(7) feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick)

(8) diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others)

(9) recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide

B. The symptoms do not meet criteria for a Mixed Episode.

C. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

D. The symptoms are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism).

E. The symptoms are not better accounted for by Bereavement, i.e., after the loss of a loved one, the symptoms persist for longer than 2 months or are characterized by marked functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.

Appendix J – *DSM-IV* Diagnostic criteria for Minor depressive disorder (15)

A. A mood disturbance, defined as follows:
   (1) at least two (but less than five) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (a) or (b):
      (a) depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful). **Note:** In children and adolescents, can be irritable mood.
      (b) Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others)
      (c) Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. **Note:** In children, consider failure to make expected weight gains.
      (d) Insomnia or hyperinsomnia nearly every day
      (e) Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness of being slowed down)
      (f) Fatigue or loss of energy nearly every day
      (g) Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick)
      (h) Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others)
      (i) Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide
   (2) The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning
   (3) The symptoms are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism)
   (4) The symptoms are not better accounted for by bereavement (i.e., a normal reaction to the death of a loved one)

B. There has never been a major depressive episode, and criteria are not met for dysthymic disorder.

C. There has never been a manic episode, a mixed episode, or a hypomanic episode, and criteria are not met for cyclothymic disorder. **Note:** This exclusion does not apply if all of the manic-, mixed-, or hypomaniclike episodes are substance or treatment induced.

D. The mood disturbance does not occur exclusively during schizophrenia, schizophreniform disorder, schizoaffective disorder, delusional disorder, or physchotic disorder not otherwise specified.

Appendix K – Multivariate Analysis with all SES measures vs. aggregate SES quartiles

Multivariate Analysis: Models predicting anxiety disorders

	OLD model B ALL SES measures		NEW model B SES quartile	
	OR	95% CI	OR	95% CI
Lifetime – Hypertension binary				
Hypertension	1.45	1.12-1.88	1.54	1.20-1.98
Hypertension	1.64	1.16-2.32	1.71	1.23-2.37
Hypertension only	1.05	0.61-1.79	1.20	0.67-3.14
Hypertension and another condition	2.21	1.60-3.05	2.30	1.69-3.12
Chronic only	1.70	1.34-2.17	1.69	1.34-2.13
12-month – Hypertension categorical				
Hypertension only	1.30	0.64-2.64	1.64	0.77-3.51
Hypertension and another condition	2.65	1.73-4.07	2.66	1.78-3.98
Chronic only	1.90	1.41-2.58	1.92	1.43-2.57

Multivariate Analysis: Models predicting depressive disorders

	OLD model B ALL SES measures		NEW model B SES quartile	
	OR	CI	OR	CI
Lifetime – Hypertension binary				
Hypertension	1.12	0.86-1.47	1.20	0.92-1.55
12 month – Hypertension binary				
Hypertension	1.08	.71-1.63	1.17	0.79-1.72
Lifetime – Hypertension categorical				
Hypertension only	0.92	0.50-1.71	0.02	0.51-1.66
Hypertension and another condition	1.69	1.25-2.29	1.83	1.35-3.47
Chronic only	1.74	1.36-2.22	1.75	1.37-2.24
12-month – Hypertension categorical				
Hypertension only	0.86	0.38-1.96	9.90	0.40-2.02
Hypertension and another condition	1.64	1.00-2.68	1.84	1.15-2.95
Chronic only	1.72	1.17-2.53	1.81	1.25-2.61

Multivariate Analysis: Models predicting comorbid anxiety-depression

	OLD model B ALL SES measures		NEW model B SES quartile	
	OR	CI	OR	CI
Lifetime – Hypertension binary				
Hypertension	1.21	0.79-1.85	1.39	0.93-2.08
12 month – Hypertension binary				
Hypertension	1.34	0.59-3.05	1.59	0.73-3.47
Lifetime – Hypertension categorical				
Hypertension only	0.79	0.28-2.23	0.80	0.28-2.28
Hypertension and another condition	1.94	1.25-3.01	2.30	1.52-3.48
Chronic only	1.80	1.22-2.66	1.82	1.25-2.67
12-month – Hypertension categorical				
Hypertension only	2.56	0.68-9.62	2.71	0.79-9.28
Hypertension and another condition	2.19	0.84-5.73	2.71	1.08-6.83
Chronic only	2.48	1.07-5.75	2.53	1.12-5.74

Appendix L: Summary of final multivariate models predicting mental disorders restricted to males only

	Anxiety		Depression		Comorbid anxiety-depression	
	OR	95% CI	OR	95% CI	OR	95% CI
Hypertension status						
None	1.0		1.0		1.0	
Hypertension diagnosis only	2.53	0.82-7.78	1.23	0.45-3.35	2.18	0.24-16.89
Hypertension diagnosis and chronic	2.31	1.34-3.98	0.79	0.33-1.86	1.03	0.33-3.27
Chronic only	1.45	0.95-2.21	1.31	0.82-2.09	1.53	0.79-2.97
Age: 18-29	1.0		1.0		1.0	
30-39	0.91	0.55-1.49	1.21	0.62-2.37	0.85	0.28-2.57
40-49	1.08	0.55-2.12	1.62	0.87-2.99	2.04	0.58-7.21
50+	0.99	0.48-2.01	1.15	0.56-2.34	0.76	0.17-3.38
Race Black	1.0		1.0		1.0	
Coloured	0.59	0.35-0.97	0.67	0.33-1.33	0.22	0.04-1.30
White	0.42	0.14-1.23	0.81	0.39-1.69	0.51	0.05-4.81
Indian/Asian	0.29	0.12-0.74	0.90	0.31-2.65	0.59	0.23-1.49
Currently married	0.79	0.50-1.22	0.91	0.55-1.53	0.58	0.23-1.49
Location: Rural	1.0		1.0		1.0	
Urban	1.26	0.83-1.93	1.22	0.76-1.94	2.14	0.97-4.69
SES Quartile – 0	1.0		1.0		1.0	
1	1.16	0.66-2.02	0.82	0.45-1.48	1.36	0.46-4.01
2	1.16	0.68-2.00	0.90	0.51-1.58	1.65	0.55-4.92
3	1.58	0.87-2.84	0.88	0.45-1.70	1.63	0.43-6.08
Alcohol: Lifetime – None	1.0		1.0		1.0	
Rare	2.07	1.06-4.02	2.89	1.40-5.94	3.87	1.12-13.25
Moderate	1.30	0.73-2.34	2.97	1.66-5.33	3.51	1.27-9.72
Heavy	1.79	0.89-3.57	1.00	0.57-1.77	1.60	0.70-3.63
Lifetime smoker	1.00	0.71-1.42	1.23	0.85-1.76	0.92	0.45-1.87
Substance Abuse Disorder	2.14	1.09-4.21	2.10	1.31-3.37	1.91	0.78-4.66
Traumatic life events – None	1.0		1.0		1.0	
1-2	1.11	0.61-2.02	2.18	1.02-4.68	2.53	0.63-10.18
3-4	1.35	0.67-2.74	2.97	1.24-7.12	5.28	1.09-25.54
5 or more	2.69	1.52-4.75	2.68	1.64-8.23	8.77	2.38-32.33

Appendix M: Summary of final multivariate models predicting mental disorders restricted to females only

	Anxiety		Depression		Comorbid anxiety-depression	
	OR	95% CI	OR	95% CI	OR	95% CI
Hypertension status						
None	1.0		1.0		1.0	
Hypertension diagnosis only	0.79	0.44-1.42	0.82	0.41-1.64	0.57	0.21-1.54
Hypertension diagnosis and chronic	1.80	1.27-2.56	1.92	1.29-2.85	2.07	1.21-3.56
Chronic only	1.57	1.22-2.03	1.76	1.24-2.49	1.68	1.03-2.74
Age: 18-29	1.0		1.0		1.0	
30-39	1.10	0.76-1.58	1.07	0.76-1.50	0.97	0.58-1.62
40-49	0.84	0.54-1.33	1.20	0.87-1.65	0.74	0.44-1.22
50+	0.85	0.52-1.39	0.68	0.44-1.06	0.66	0.34-1.26
Race Black	1.0		1.0		1.0	
Coloured	0.79	0.46-1.35	0.97	0.59-1.60	0.83	0.42-1.62
White	0.55	0.25-1.19	0.74	0.31-1.79	0.62	0.20-1.90
Indian/Asian	0.65	0.28-1.51	1.55	0.68-3.52	0.80	0.35-1.85
Currently married	1.00	0.77-1.29	0.92	0.73-1.17	0.99	0.71-1.38
Location: Rural	1.0		1.0		1.0	
Urban	1.37	1.08-1.74	1.01	0.70-1.43	1.87	1.21-2.90
SES Quartile – 0	1.0		1.0		1.0	
1	0.86	0.66-1.12	0.79	0.53-1.17	0.81	0.51-1.31
2	0.99	0.70-1.38	0.89	0.60-1.34	0.65	0.38-1.12
3	0.95	0.61-1.48	1.17	0.69-2.00	0.97	0.47-1.97
Alcohol: Lifetime – None	1.0		1.0		1.0	
Rare	1.60	0.89-2.88	1.70	0.95-2.06	2.45	0.98-6.11
Moderate	1.16	0.59-2.28	0.99	0.53-1.85	1.32	0.53-3.30
Heavy	1.97	1.11-3.50	1.48	0.84-2.62	2.12	1.06-4.25
Lifetime smoker	1.30	0.94-1.80	1.85	1.14-3.01	1.50	0.87-2.59
Substance Abuse Disorder	2.12	1.2-3.75	1.66	0.98-2.79	1.90	0.85-4.23
Traumatic life events - None	1.0		1.0		1.0	
1-2	1.71	1.24-2.36	1.86	1.23-2.82	1.49	0.83-4.23
3-4	1.94	1.28-2.94	2.96	1.72-5.09	2.86	1.42-5.77
5 or more	2.34	1.59-3.46	3.73	2.21-6.31	3.55	1.72-7.33