The Intergenerational Transmission Effect of Depression:

Causality, Resilience & Decomposition

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Abstract

Since the 1990s, the burden of disease associated with poor mental health has continued to rise in South Africa. One third of South Africans will suffer from poor mental health in their lifetime if either parent also suffers from poor mental health, and this intergenerational transmission effect of depression is large and highly significant. Previous work has attempted to investigate whether it is nurture or nature effects which drive this large transmission effect. While this work has found that it is primarily environmental factors which account for this transmission of depression from mother to child, this does not properly identify the extent of each component, and in which contexts the one is more important than the other. Despite the prevalence of poor mental health, the intergenerational transmission of mental illness in South Africa is equally understudied. Investigating whether this intergenerational transmission of depression is a causal effect or merely a correlation poses a major challenge for inference. This thesis estimates causality in the intergenerational transmission effect of depression from parent to individual, and finds that parental depression is the the single largest determinant of individual depression. That is, individuals with depressed parents are more likely to suffer from depression themselves. This thesis also attempts to explore vulnerability and resilience to this transmission effect and finds that a mother's depression is the largest and most important determinant of transmission of depression from a father. The opposite is also true - a father's depression is the single and largest determinant of transmission of depression from a mother. Upon further investigation of the key determinants of resilience or vulnerability to transmission using the Least Absolute Shrinkage and Selection Operator (lasso) model, this paper finds that hardly any other genetic or environmental characteristics have been found to be significant determinants of transmission. Parental depression alone has the largest effect on whether an individual is resilient or vulnerable to transmission from another parent. This paper finds that the environment does not seem to have as large of an effect on resilience or vulnerability to transmission of depression as was previously thought in the literature - only parental depression seems to have an effect on transmission of depression.

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1 Introduction

The global burden of disease attributable to poor mental health has risen sharply given major changes in global demographic, environmental, and sociopolitical factors. Despite substantial research on global mental health in reference to the Sustainable Development Goals (SDGs) to prevent and treat poor mental health, not many interventions have not materialised (Patel et al. 2018). In many developing countries, including South Africa, mental health has long been a neglected public health and policy issue (Pillay 2019).

Poor mental health is associated with adverse effects on employment and education attainment resulting in reduced earnings ability (Lund et al. 2011, Ardington & Case 2010). Both the international and South African literature suggest that mental health, general health status and socioeconomic status are important determinants of an individual's well being (World Health Organization et al. 2008, Ardington & Case 2010). While mental health data is available in South Africa, the long-term effects of mental health are understudied, largely due to a previously limited availability of nationally representative data as well as a lack of epidemiological research on the major depressive disorders in the country (Tomlinson et al. 2009).

In 2007, poor mental health constituted 14 percent of the global burden of disease (Prince et al. 2007), and was expected to be the second highest cause of health disability by 2020 (Blas & Kurup 2010). In South Africa, depression contributes 5.8 percent of the overall burden of disease (Jack et al. 2014), while one in five adults live under the food poverty line (Statistics South Africa 2018) and more than 60 percent of children are regarded as multidimensional poor (Maluleke 2020, Garman et al. 2022). Post-apartheid South Africa is a context in which there continues to be endemic social problems (Masenya et al. 2017). Poverty, economic inequality, racial and ethnic discrimination as well as, gender discrimination, have been found to independently correlate with individual covariates of depression (Tomita et al. 2015*a*, Eyal et al. 2018).

Parental depression is found to be a significant determinant of the onset of an individuals

depression at an early age (Goodman 2020, Beardslee et al. 1998, Kieling et al. 2011). Research has shown that longer and more persistent, more severe, or more frequent episodes of maternal depression are related to inadequate parenting or lower quality parenting parenting and more adverse outcomes in children (Netsi et al. 2018). The earlier a parent suffers from depression in their life, there is a higher probability that the parent themselves have had multiple depressive episodes resulting in earlier and more frequent exposures for their children (Goodman 2020).

Within family structures, mental health is closely related and consequently, mental illness of family members has been found to negatively impact individual mental health (Goodman 2020, Lester & Akande 1997). Similarly, the odds of suffering from depression increase with the probability of having more relatives who also suffer from depression, suggesting even greater heritability (Goodman 2020). However, transmission of poor mental health, the size and causal interpretation of this intergenerational in Africa and South Africa are equally understudied (Eyal et al. 2018, Eyal 2016).

It is found that symptoms of depression tend to emerge at the start of the adolescent-stage when an individual is 15 years old (Hankin et al. 1998, Kessler & Walters 1998), and is especially prevalent among women (Goodman 2020), people of colour (Garber 2007, Rudolph 2009, Patel et al. 1999, Ardington & Case 2009), those who belong to a lower socioeconomic status, for those with financial stress (Lund et al. 2011), those living in larger households and in rural or urban informal areas. As well as these factors, depression rates are nearly three times higher for those with a first degree-relative who is depressed (Eyal 2016, Eyal et al. 2018).

The literature suggests that the size of the intergenerational transmission of depression is large and significant across many countries (Eyal et al. 2018, Currie & Stabile 2007, Ensminger et al. 2003, Frank & Meara 2009). Among the significant determinants of the intergenerational transmission of depression, current maternal depression (Goodman 2007) is the single largest and most significant determinant (Ardington & Case 2010, Arding-

ton & Case 2009). Maternal depression and the causal effect it may have on individual depression emphasises the genetic component of the intergenerational transmission effect of depression (Goodman 2007, Goodman & Tully 2006, Goodman & Gotlib 1999). A shared family environment captures the environmental component of the transmission effect (Kim-Cohen et al. 2005).

The episodic nature of depression indicates the necessity of including a temporal component to any analysis of the transmission effect. In addition to the importance of factoring in time dimensions to transmission, the severity of depression must also be considered. The literature regarding estimates of the severity of parental transmission of depression in Africa and South Africa is scarce (Strauss & Thomas 2007, Tomita et al. 2015*b*, Akbulut & Kugler 2007, Eyal et al. 2017). Underscoring the link between maternal and own depression, randomised clinical trials of psychotherapy for depressed mothers showed that psychotherapy was significantly associated with improved mental health of their children (Cuijpers et al. 2015, Goodman 2020).

This paper makes use of various techniques to to attempt to uncover a causal effect for maternal depression on individual depression rather than a correlational estimate. Paternal transmission is also examined, despite the associated smaller sample size in these estimates. This parental transmission effect is investigated to further examine vulnerability or resilience to transmission. Finally, this paper investigates the components and characteristics of transmission further by determining the relative importance of these determinants of transmission.

In some literature twin data has been used to isolate this causal effect however data on twins is limited, particularly in South Africa (Bowles & Gintis 2002, Eyal et al. 2018). Studies on identical twins who have closely matched, if not identical DNA capture a representative view of the potential gene and environmental influences of depression (Harris et al. 2002). The lack of representative data on twins in South Africa also creates a challenge in accurately disentangling these intergenerational transmission effects using

this approach. While twin data is limited, in comparison to many other countries, South African households have useful characteristics, such as larger household size, and a higher likelihood of three generation households containing multiple related and unrelated household members (Statistics South Africa 2021). This makes it possible to exploit South Africa's unique household structure and the varying degrees of genetic relatedness present in households to investigate the intergenerational transmission effect.

This paper is organised as follows. Chapter 2 discusses mental health, its prevalence as well as resilience and vulnerability to the intergenerational transmission of depression. Chapter 3 discusses the data and the depression measures used in this analysis. Chapter 4 investigates the effect that parent's depression has on individual depression, both graphically and using descriptive statistics to examine the differences in key characteristics by depression status. Chapter 5 presents estimates for causality in this intergenerational transmission effect between individuals and their parents using regression analysis across a number of models. This chapter also investigates potentially confounding factors and robustness checks of these results. Chapter 6 explores the nature of transmission by examining the determinants of transmission according to a theory of resilience protecting individuals from being affected by their proximity to parents with poor mental health. Given that both genetic and environmental factors play a role in determining transmission, the relative importance of these factors will also be explored using the Least Absolute Shrinkage and Selection Operator (lasso)[1] model. Chapter 7 concludes.

2 The Burden of Mental Health

In this section the determinants, intergenerational transmission effects and prevalence of mental illness are discussed. the literature provides a number of the techniques by which the effect size can be estimated, and whether these techniques could be plausibly considered as causal.

[1]Least Absolute Shrinkage and Selection Operator (lasso) estimates model coefficients estimates can be used to select which covariates should be included in a model. The lasso is used for outcome prediction and for inference about causal parameters (Wang et al. 2007, Bühlmann 2010)

2.1 Determinants

This section will examine the determinants of poor mental health.

According to the World Health Organisation (WHO), the determinants of mental health include and are affected by genetics, behavior, environmental and physical influences, medical care and social factors (World Health Organization et al. 2008). There are notable differences in determinants across different income categories for different countries. However, in South Africa and similarly diverse countries, current maternal depression (Garber & Cole 2010, Tomita et al. 2015*a*, Eyal et al. 2017, Eyal & Burns 2019, Goodman 2007) is the single largest and most significant determinant of depression (Ardington & Case 2010, Ardington & Case 2009). Similarly, having both parents depressed is a significant determinant of the onset of depression at an early age (Garber 2007, Beardslee et al. 1998, Kieling et al. 2011).

Resilience to unfortunate circumstances, or to the environmental or genetic factors associated with mental illness has been recognised as a key trait in whether a person develops mental illness or not (Edward 2005). Also identified in the literature as "grit", inner strength, or hardiness, it is acknowledged as the ability of a person to continue to function in environments with high levels of danger or stress (Musumari et al. 2018, Duckworth et al. 2007, Duckworth & Quinn 2009). A resilient individual may suffer from a bout of depression but may be able to move on and recover without the condition becoming chronic (Kaplan & Sadock 1989).

While grit and resilience are interesting factors to explore, they are not independent predictors of mental health. For example, South African data shows that resilience brought on by income represents an exogenous shock (Eyal & Burns 2019). Considering this, grit and resilience are thus part and parcel of one's mental health constituency. On the one hand, resilience may have a genetic component, as does mental health, and presumably, this genetic component could differ in these two domains, although be highly correlated.

On the other hand, many of the factors that affect resilience are also predictive of mental health, further making the question more complex and difficult to fully disentangle the two. For example, if older age is associated with worse mental health, this naturally implies lower resilience (otherwise mental health would not worsen). Thus, given that grit and resilience are difficult to determine from a data perspective, they represent latent variables which are unobserved and are based on speculation.

There is an increasing amount of evidence showing that grit is associated with various indicators of well-being outcomes, for instance, life satisfaction and psychological well-being. Grit encapsulates two important components - consistency and persistence of effort in pursuing long-term goals. Grit and resilience have protective effects against adverse mental health outcomes (Musumari et al. 2018). Due to a propensity to experience obstacles and failures in a positive way, resilient people are likely to be less prone to adverse mental health outcomes. While studies linking grit to mental health outcomes have been scarce (Duckworth & Quinn 2009), the literature is growing, with recent studies in the Philippines, China and the United States (Zhang et al. 2018, Sharkey et al. 2018, Datu et al. 2019).

A parent suffering from poor mental health is another important factor in the environment and resilience (in the form of coping methods) that helps to determine whether a child will also begin to suffer from poor mental health (Ohtani et al. 2020). There are a number of models in the psychological literature which predict resilience and examine resilience in the psychological literature. Resilience has been identified as as a key determinant of not only depression (Herrman et al. 2011) but also of other outcomes such as cognitive function, stress, PTSD, and anxiety (Nock et al. 2014, Yehuda 2004, Kaplan & Sadock 1989). Whether resilience can be seen as a personality trait, an innate physiological quality, genetic, or a quality acquired through life experience is a topic of discussion (Kaplan & Sadock 1989), and it is possible that it could be a combination of these factors.

As with those who have parents with mental illness presenting with a higher tendency

to mental illness (Garber & Cole 2010), similar patterns exist for those who suffer from deprivation during childhood - they are less likely to be resilient (Garber 2007, Rudolph 2009, Hammen et al. 2011). The ability to withstand severe, repeated traumas, or recover from them, is what defines psychological resiliency. The ability to regulate these psychological and often physiological responses to stress and anxiety are facilitated by two hormones produced in the brain, dehydroepiandrosterone and neuropeptide Y (Traish et al. 2011, Goodyer et al. 2000, dos Santos et al. 2013). Both of these neurochemicals have been found to be associated with higher levels of resilience (Petros et al. 2013, Cohen et al. 2012, Lau et al. 2021).

Genetic factors are also associated with physiological resilience, while neuroendocrine reactivity,[2] sleep, environment, nutrition, religion have also been found to mediate resilience (Kaplan & Sadock 1989). Resilience to poor mental health has been associated with higher self-esteem, positive caregiver–child relationships, parental involvement as well as family, peer, and community support (Veselska et al. 2009, Coon 2012, Wong 2008).

The opposite end of this stress spectrum is characterized by chronic stress, where repeated or prolonged stress may result in dysregulation or suppression of the immune system which occurs in those who are deemed to be vulnerable to mental illness. This results in increased exposure to stress hormones and these physiological stress responses are found to persist long after the onset of stress (Charney 2004, Kaplan & Sadock 1989).

There are mechanisms related to reward and motivation such hedonism, optimism, and learned helpfulness, effective behaviors despite fear, altruism, bonding, and teamwork which have been found to promote resilience (Charney 2003). A lack of these mechanisms is found to be relevant to character traits associated with vulnerability to mental illness (Culbreth et al. 2018).

Chronic and long-lasting stress can be harmful and affect health adversely and there

[2]The neuroendocrine system is the mechanism by which the hypothalamus maintains homeostasis, regulating reproduction, metabolism, eating and drinking behaviour, energy utilization, osmolarity and blood pressure (Nishiyama & Katsura 2015).

is emerging evidence indicating that genetic factors contribute to the vulnerability to post-traumatic stress disorder (PTSD) (Nock et al. 2014). Pain disorders attributed to psychological factors, referred to as psychogenic factors, also have the power to generate stress long after exposure to stress especially for individuals with PTSD, schizophrenia or those experiencing chronic psycho-social conflicts (Bleuler 1930, Nock et al. 2014).

A particularly vulnerable group identified in the literature is women (Ardington & Case 2009). In South Africa, this vulnerability is exacerbated by lower socio-economic status, domestic violence and a real threat of gender based violence (Amstadter et al. 2016). Vulnerability is also exacerbated by the high burden of care-giving due to the high prevalence of HIV (Kagotho & Ssewamala 2012) and the lack of stable partners given high paternal absence in South Africa (Van den Berg & Makusha 2018). Research has also shown that Black women are vulnerable to depression due to chronic environmental stress relating to racism, sexism and poverty (Martin et al. 2013). Similarly, people who live in low income households and those in poor health are also particularly vulnerable to mental illness (Gibbs et al. 2018, Nyirenda et al. 2013, Cutrona et al. 2006, Grant & Brito 2010).

While increasing age is also associated with lower resilience (Jeste et al. 2013), those who live with other depressed relatives are also are more vulnerable to depression themselves if their parents are also depressed. However, it is important to remember that most people are actually resilient (Kaplan & Sadock 1989). In the NIDS, of those who were depressed in a previous wave, only 25 percent became depressed when living with a depressed mother.

According to research, promoting resilience against anxiety in adolescents by intervening early on in life is crucial (Kaplan & Sadock 1989). A child's level of resilience against developing mental illness is similarly strengthened by having a degree of emotional stability prior to the onset of the illness, a high level of support in the family or household and higher socioeconomic status and access treatment (Henje Blom et al. 2014). The main focus of intervention during treatment is on the primary caregivers of children (Radovic et al. 2015), and may include parenting support and psychological education,

careful guidance regarding potential to damage self-esteem, and techniques for building self-acceptance and resilience in the child (Kaplan & Sadock 1989).

Research shows that social support and positive community influences have the power to increase resilience (Coon 2012). Furthermore, while psychological resilience is also influenced by genetics, studies on twins show that environmental influences have also been found to have an enduring effect on resilience (Amstadter et al. 2016). For example, early childhood experiences, coping mechanisms, optimism and social support were found to mitigate against stressful life events such as marital or familial relationship issues such as divorce, job loss, loss of a family member, chronic physical illness, major financial or legal issues, assault or being robbed (Kim-Cohen et al. 2004, Boardman et al. 2008).

The characteristics of a resilient family such as family flexibility, maintaining a commitment to the family unit, open communication, engaging in active coping efforts and maintaining social integration have also been found to promote resilience (Black & Lobo 2008, Kaplan & Sadock 1989). Given high levels of poverty, inequality and paternal absence in South African households, interventions which promote resilience within in families are crucial. Intervention can be multi-systemic and may include, for example, family-based therapy to facilitate communication (Diamond et al. 2000). In addition, given the common co-morbidities of poor mental health in South Africa, promoting safe disclosure of HIV status in the family, peer support groups with other families as well as community programs which reduce HIV and mental health stigma are also crucial (Ma et al. 2019).

There have been a number of successful, low-cost, community-led interventions to treat poor mental health implemented across sub-Saharan Africa (Keynejad et al. 2020, Bitew et al. 2021). In Zimbabwe, problem-solving therapy (PST) has shown to be successful in supporting adult patients with poor mental health (Bell & D'Zurilla 2009, Nezu et al. 2012). The Friendship Bench program was developed in 2006 and has contributed significantly towards narrowing the treatment gap for common mental illness in Zim-

babwe. The program makes use of problem-solving therapy provided by a trained lay health workers and has been scaled to over 70 primary health care facilities. PST has been effective in improving adherence in medication and psychological treatments (Nezu et al. 2012), and is widely supported by the Zimbabwean Ministry of Health and the City Health Departments (Wallén et al. 2021, Fernando et al. 2021).

Integrating programs which aim to address and alleviate poverty while providing mental health services is highly likely to improve resilience in vulnerable groups (Stallard et al. 2005). For individuals experiencing repeated mental health crises when treatment is too expensive or inaccessible, it may also be more effective to employ other protective interventions to promote resilience to poor mental health such as building community based relationships and spirituality to find strength in struggle (Haglund et al. 2007, Kaplan & Sadock 1989).

2.2 The Intergenerational Transmission of Depression

The literature suggests that the largest predictor of child status is that of their mother's status (across multiple outcomes such as education and health etc. and not only mental health status (Burns & Keswell 2012). In South Africa, the intergenerational effect of maternal depression is large and highly significant (Eyal & Burns 2019). Contrarily, very few studies have examined this connection (Eyal et al. 2018, Tomita et al. 2015*b*, Eyal et al. 2017) and estimates of the intergenerational transmission effect are both scarce and varied (Akbulut & Kugler 2007, Moultrie & Kleintjes 2006, Eyal & Burns 2019). Despite the fact that, poor maternal mental health has been found to impact negatively on individual outcomes in other countries (Hammen et al. 2011, Eyal et al. 2018, Currie & Stabile 2007, Ensminger et al. 2003, Frank & Meara 2009) and, that the size of the intergenerational transmission effect is significant across many low income countries such as Ethiopia and Nigeria (Hanlon et al. 2009, Adewuya et al. 2006), it is equally understudied in South Africa (Eyal et al. 2018, Eyal 2016).

Given that depressive symptoms are especially prevalent for women (Pawlby et al. 2009, Hanlon et al. 2009, Orr et al. 2002), the younger an individual is when their mother suffers from depression, the more likely they are to suffer from depression later in life themselves (Hammen et al. 2012, Garber & Cole 2010). As opposed to non-depressed mothers, depressed mothers tend to have more disengaged, hostile and possibly more coercive parenting behaviours which have been found to have long-term effects which are apparent long after childhood. Children who have depressed mothers may develop emotional conduct disorders due to disruptions in the maternal care-giving environment (Garber & Cole 2010, Kim-Cohen et al. 2005). This is especially problematic for high risk adolescents due to the formative nature of this stage in development (Viner et al. 2012) where, for adolescents, mental health is among one of the leading burdens of disease (Kieling et al. 2011, Eyal et al. 2018).

Many studies do not attempt to disentangle the genetic and environmental factors in transmission effects of any topic (Van Ijzendoorn 1992) and the interaction of these two components have been scarcely studied. In fact many studies largely ignore the genetic component and subsequently overestimate the environmental and social component in the transmission effect (Kim-Cohen et al. 2005).

Previous work has attempted to investigate whether it is the nurture effect or the nature effect which drives this large transmission effect. While this work has found that it is primarily environmental factors which account for this transmission of depression from mother to child, it does not properly identify the extent of each component, and in which contexts the one is more important than the other. Understanding the relative connection can be explained by the following model (Thompson 2014) which exhibits similar characteristics to models found in the literature (Akbulut & Kugler 2007),

$$MH_i = f(X_i, HH_i, C_c, P_p, PD_p) \tag{1}$$

This model suggests that mental health is a function of X_i individual level factors such as age, gender, health, education, race, nationality, self-esteem and loneliness. HH_i per-

tains to household level factors such as household income among others. C_c pertains to community factors such as community size, access to services or transport, levels of safety and social cohesion (Tomita & Burns 2013). P_p refers to parent level characteristics such as mother's health, age, education and labour market status.

Investigating whether maternal depression is causal to current individual depression is challenging as the causality could go either way, and this is part of the classic Manski "reflection problem" (Manski 1992) which is also key aspect of investigating outcomes for siblings. This problem is most prevalent when one tries to predict the behavior of an individual by the behavior of the group of which the individual is a member. This means that component of maternal depression and the effect it has on current individual depression could possibly emphasise a genetic component of the transmission effect (Goodman 2007, Goodman & Tully 2006, Goodman & Gotlib 1999) and, while this could be plausible, it implies a difficulty in correctly identifying the coefficient on maternal depression. This is because apparent endogeneity could be instead representing a correlation and not a causal link. However, this endogeneity problem could possibly be accounted for by an related instrumental variable approach including the infant child death (maternal still-birth) as a proxy for the maternal depression. Paternal depression is insignificant in most cases and it is clear that even when it is not accounted for, improved maternal mental health regulates the parenting and care-giving environment. Absent fathers suffering from depression, however, still pose a genetic liability to their children (Kim-Cohen et al. 2005).

Creating an interactive model that takes into account both stress and resiliency factors that are responsive to individual and cultural differences remains challenging (Kaplan & Sadock 1989). In other studies of the transmission of different traits, including cultural norms, three different types of transmission are identified: vertical (from parent to child), oblique, through role models who are not parents (these could be aunts, uncles, grandparents or any other role model) and horizontal, from one's peers (these could be siblings, cousins, or unrelated peers) (Bisin & Verdier 2011).

This paper mainly focuses on vertical transmission through mother and father to individual, although oblique and horizontal transmission is investigated towards the end of Chapter 6, to examine similarities and differences to the primary estimates. The next section discusses vulnerability and resilience to transmission given the theory that resilience has a protective effect against transmission of depression from a parent.

2.3 Prevalence

Since the 1990s, the burden of disease associated with poor mental health has continued to rise in South Africa (Eyal et al. 2017, Jack et al. 2014). While one-third of South Africans will suffer from poor mental health in their lifetime if either parent also suffers from poor mental health (Herman et al. 2009, Lund 2012, Eyal et al. 2017, Eyal & Burns 2019), mental health is largely understudied in South Africa. This is largely due to limited nationally representative data and the lack of epidemiological research on mental health in most developing and low to middle income countries (Tomlinson et al. 2009).

According to the Lancet Commission on global mental health and sustainable development, in low- and middle-income countries, the quality of mental health services are substantially lower than the quality of physical health care services. In addition, government investment and development assistance for mental health remains inadequate (Patel et al. 2018). In 2010, less than 2 percent of facilities allocated to mental health services catered specifically to teens and children in South Africa (Lund et al. 2010, Eyal et al. 2018, Kieling et al. 2011). By 2018, only slightly more than 4 percent of public health funds were allocated to mental health and, only 27 percent of South Africans with severe mental disorders received treatment (Docrat et al. 2019, Pillay 2019).

South Africa is one of the most unequal countries in the world (Blas & Kurup 2010) and overall income inequality is very high. Economic inequality has been widely associated with higher levels of poor mental health (Eyal et al. 2017, Blas & Kurup 2010). Inequality generated in the labour market has been found to be a key driver of inequality in

South Africa (Kerr et al. 2021). In addition, post-apartheid changes in earnings inequality, measured by the Gini coefficient, have increased since the 1990s, stabilising at even higher levels in the early 2000s (Wittenberg 2017, Kerr et al. 2021). Since 2017, rates of depression in South Africa have been reported to be even higher, with levels of depression in the region of 24 to 29 percent recorded in 2020. According to NIDS-CRAM, rates of depression are much higher at 52 percent since the onset of the Global Covid-19 pandemic in March of 2020 (Hunt et al. 2021).

Poor mental health has been found to have a negative impact on individual outcomes, both physical and mental, in similarly diverse countries such as Pakistan, Vietnam, and Barbados (Hammen et al. 2011, Prince et al. 2007, Eyal & Burns 2019). Individuals living in poverty are more likely to experience the effects of poor mental health (Lund et al. 2011, Patel & Kleinman 2003) and these conditions place individuals in low- to middle-income countries at particularly high risk of poor mental health. In addition, poverty has been found to erode the protective nature that education and income from employment can have on household socioeconomic status and mental health (Ardington & Case 2010).

The prevalence of depression in South Africa is significantly high, and differs considerably between population groups (Ardington & Case 2010). Rates of depressive symptoms have been found to be higher among women (Bromet et al. 2011, Moultrie & Kleintjes 2006) and young people (Myer et al. 2009), with estimates of adolescent depression between 13 and 17 percent in 2017 (Myer et al. 2009, Plüddemann et al. 2014, Eyal & Burns 2019). Rates of depression have also been found to be higher among people of colour (Ardington & Case 2009) and for those who belong to a lower socioeconomic status. This is particularly true for those with decreased mental bandwidth due to contextual stress (Sheehy-Skeffington & Haushofer 2014) related to financial difficulties such as debt, loss of employment, discrimination or interpersonal violence (Nwosu & Oyenubi 2021, Posel et al. 2021, Organization 2020, Lund et al. 2011).

The gendered differences in the prevalence of depression are common in psychiatric epidemiology. The gendered differences in depression rates first emerge in adolescence (Salk et al. 2017, Hankin et al. 1998) and continue through to old age, although, the gender gaps for adults are smaller than those for younger individuals (Zhao et al. 2020, Angold & Worthman 1993). By adolescence, girls might have learnt to have more negative self-esteem due to how women are often represented and treated in society (Beck 2008, Bone & Lewis 2020). Boys exhibit more externalizing symptoms, while girls possess more internalizing symptoms. Internalizing symptoms may be displayed as excessive worry, withdrawal, sadness, shyness, insecurity or fear (Baptista et al. 2017).

On average, depression rates for Black/African[3] women have been found to be 43 percent higher than those of women in other racial groups (Ardington & Case 2010, Moultrie & Kleintjes 2006, Brown et al. 2011, Lund 2012). Across all genders, 60 percent of the difference in depression rates between Black/Africans and the rest of the population can be explained by low socioeconomic status and residence in rural or urban informal areas (Ardington & Case 2010, Blas & Kurup 2010). While the rates of poor mental health of women in South Africa are high and very significant in the literature, recent data shows that men in South Africa have also been found to exhibit similar rates of depression (Ezeugwu & Ojedokun 2020).

Rates of depression are also high for those living in larger households, those residing in rural and urban informal areas (as mentioned), those who are lacking the ability to fulfil basic needs such as stable housing, employment, and sufficient food (Jack et al. 2014, Hunt et al. 2021), among many other factors. Mental health is closely related within family structures and consequently, poor mental health of family members has been found to negatively impact individual mental health (Lester & Akande 1997). As such, depression rates are nearly three times higher for those with a first degree-relative who is depressed (Sullivan et al. 2000, Eyal et al. 2018).

[3]The Black/African racial descriptor is intentionally used throughout this paper and is based on the racial descriptors used in the NIDS questionnaires (SALDRU 2017)

Given current maternal depression (Garber & Cole 2010, Tomita et al. 2015*a*, Eyal et al. 2017, Eyal & Burns 2019, Goodman 2007) is the single largest and most significant determinant (Ardington & Case 2010, Ardington & Case 2009), in high income countries such as the United States, Australia and Denmark, the risk of depression if a parent is depressed is up to five times higher than the risk for individuals whose parents do not suffer from depression (Akbulut & Kugler 2007, Hammen et al. 2004, Hammen et al. 2011, Hammen et al. 2012, Strauss & Thomas 2007).

While depression rates in South Africa are much higher than rates of depression in similar countries (Herman et al. 2009, Ardington & Case 2010), low to middle income countries in Latin America, Africa, and the Middle East mental health outcomes are improving due to targeted government interventions such as positive income shocks (Viner et al. 2012) in the form of cash transfers (Samuels & Stavropoulou 2016, Eyal & Burns 2019). The social determinants of depression, such as relative poverty and income inequality, are often more apparent, however, the effects that poor mental health may have on physical health and the subsequent ability to obtain education to attain employment are less so (Hunt et al. 2021).

In 2018, 40 percent of South Africans with HIV/AIDS suffered from poor mental health (Pillay 2019). The consequences of untreated mental health include reduced productivity, earnings ability and the risk of physical comorbidities of poor mental health such as Tuberculosis, HIV/AIDS, anxiety disorders and substance abuse (Goodman 2020, Garber 2007, Rudolph 2009, Sapolsky 2000). These effects further perpetuate income inequality and the cycle of poverty (Leibbrandt et al. 2009, Lund et al. 2011, Ardington & Case 2010).

The attitudes regarding mental health and the lack of literature on the adverse effects of depression in South African communities outline the necessity of widening the understanding depression and mental health in South Africa in order to improve policy research and outcomes. The following section discusses the intergenerational transmission of depression.

3 Methodology

3.1 Data

The data used in this paper is from the National Income Dynamics Study (NIDS). The NIDS is South Africa's first nationally representative panel survey that measures welfare over time outlining income, assets and expenditure in addition to a range of demographic variables.

The NIDS is collected through a process of face-to-face interviews and includes a psychometric scale which produces a rich set of emotional health variables (Chinhema et al. 2016, Leibbrandt et al. 2009). A computer-assisted interviewing system was used to collect data, with android mobile devices and questionnaires available in all 11 official languages. All participants involved in the study were required to be 15 years or older to complete an individual adult questionnaire. A household questionnaire was also completed by the household head or person most knowledgeable about the household's expenditure (Chinhema et al. 2016, Leibbrandt et al. 2009).

There has been a lack of studies which estimate the prevalence of mental health at a population level in South Africa. The NIDS is important as, in South Africa, the last survey charting psychiatric disorders was conducted in 2002 (Herman et al. 2009, Eyal & Burns 2019). While surveys which collect information on mental health and socioeconomic status exist, nationally representative and longitudinal household surveys are equally rare in Africa (Tomlinson et al. 2009).

Wave 1 of the NIDS was conducted in 2008 and subsequently four additional waves have been conducted approximately every 2 years. Surveys were also conducted in 2010, 2012, 2014, with Wave 5 being the most recently publicly conducted and released in 2017 (Brophy et al. 2018, Leibbrandt et al. 2009).

The NIDS contains other measures of well-being such as life satisfaction, happiness and self-perceived health which will also be explored. However, to facilitate easy comparison with other literature, the main variable used in this paper is the CES-D 10 score. The CES-D data is collected in the NIDS for those aged fifteen and above and will be discussed in the section that follows.

3.2 Descriptive Statistics

Table 1 presents sample means for individual characteristics across all five waves of the NIDS, while in Table 2, descriptive statistics providing a view of the distribution of the CES-D 10 items and responses are reported. Finally, in Section 3.3, Table 3 presents mean depression characteristics for the family according to a CES-D 10 score of 10 or above are presented. While this thesis acknowledges how the mean and standard deviations of the CES-D scale are affected when the data is pooled, this is however beyond the scope of this thesis and future work will explore how the pooled data affects the mean outcomes further.

While the limitations are acknowledged, there are benefits to pooling the data such as large sample size. It is useful to pool the data such that those results can be compared directly to the subsequent fixed effects estimates, which could potentially help to deal with the episodic nature of depression. For example, an individual maybe not be depressed in a particular wave, but in subsequent wave they may be depressed - if the thesis only accounts for wave 5 for instance, or other waves separately, then this effect would not be accounted for. While this may introduce correlation in standard errors, the results have been clustered at the individual level by PID and they can see the results in appendix item A.1 in Table 21 where a similar patterns of significance for your main coefficients of interest is observed - that is, parental depression.

In Table 1, as expected, there are fairly high levels of depression in this sample. One in four individuals is depressed according to a CES-D 10 cut off of 10 or above, while 4 percent of the sample is severely depressed according to a cut of 16 for the same scale.

Comparably, one in five people is depressed according to the CES-D 8 score. The sample sizes for CES-D 8 related characteristics are slightly higher than CES-D 10 related characteristics given the lower CES-D 8 cut off score (and the removal of positively worded items).

With a slightly higher sample size of 76,297, average education in the sample is equivalent to Grade 9, three grades before matric (Grade 12), and as expected, average employment is 30 percent with a similar sample size. Although this rate of employment is seemingly low, in 2021, South Africa had an expanded unemployment rate of approximately 47 percent. This rate includes discouraged job-seekers who have given up looking for work. While there has also been a 16 percent increase in the number of discouraged job-seekers in South Africa, these rates are the highest recorded since the start of the Quarterly Labour Force Survey (QLFS) in 2008 (Maluleke 2021*b*).

Average age in the sample is 32.6 years and 81 percent of the sample identifies as Black/African while only 14 percent identifies as Coloured. Sample sizes of individual characteristics don't differ much to one another. This is with the exception of whether an individual has ever had a still-born child,[4] where sample size is roughly half at 33,925 and average still-births is 21 percent. On average, the risk of a still-birth is 22.7 still-births per 1,000 total births in sub-Saharan Africa. In high-income countries, the rate is much lower at 3.0 still-births per 1,000 total births (Hug et al. 2020).

[4]The question, "have you ever given birth to a son or a daughter who was born alive (cried out), but later died? Please tell us about that child even if he/she died after only a few hours or days?" in the adult questionnaire of the NIDS is only asked of women (SALDRU 2017)

Table 1: Mean Individual Characteristics

Mean Individual Characteristics					
			Mean		
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Poor Health	0.13	0.12	0.14	0.11	0.12
Ever had Still-born Child	0.71	0.68	0.73	0.70	0.71
Currently Pregnant	0.95	0.95	0.90	0.91	0.97
Education in Years	8.24	8.25	8.20	8.24	8.10
Age	26.4	26.4	26.4	26.4	26.4
Employed	0.25	0.27	0.27	0.26	0.24
Female	0.55	0.56	0.55	0.57	0.58
Black/African	0.82	0.82	0.82	0.82	0.82
Coloured	0.14	0.13	0.14	0.13	0.12
Household is in Rural Area	0.52	0.52	0.52	0.52	0.52
Household Size	5.91	5.91	5.91	5.91	5.91
Household Grant Income	1,609	1,612	1,611	1,612	1,613
Mother Education	9.10	9.10	9.10	9.07	9.07
Mother Age	42.5	42.3	42.5	43.0	42.6
Mother Employed	0.27	0.26	0.27	0.28	0.27
Mother is Resident in HH	0.50	0.49	0.50	0.52	0.50
Other Parent is Resident (Father)	0.48	0.48	0.48	0.48	0.48
Mother is in Poor Health	0.25	0.25	0.23	0.25	0.23
Mother Ever Had Still-born Child	0.57	0.57	0.58	0.57	0.59
Father Education	8.96	8.90	8.96	8.80	8.76
Father Age	48.7	48.2	48.7	48.6	48.7
Father Employed	0.44	0.44	0.43	0.44	0.41
Father is Resident in HH	0.32	0.32	0.32	0.32	0.32
Other Parent is Resident (Mother)	0.79	0.79	0.78	0.79	0.79

This table presents mean values of individual and household characteristics using a sample of individuals aged fifteen to fifty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in

Of a majority Black/African and Coloured sample, where half live in rural areas, large households are common. While the value of average grant income itself is not as important, the fact that nearly 49,000 individuals in the sample live in households which receive grant income is.

Table 2 presents sample means for parental characteristics. Compared to Table 1, sample sizes are much lower across all parental characteristics. For mothers, this is explained by

the sample size of maternal residence which is comparable to the sample size of maternal depression and other maternal characteristics given that depression data is only recorded for resident household members. The same is true for fathers and other paternal characteristics. It follows that the number of individuals who have depression data for their father is almost one third less than depression data recorded for mothers. This reduced sample size is due to only 32 percent of individuals living with their fathers in the household.

Table 2 presents a more highly depressed sample where a third of mothers are depressed and average education is even lower than in the full individual sample. These mothers in this sample are older and even fewer of them are likely to be employed. One in four mothers are in poor health, while the same is true for depressed fathers.

Average familial depression in the household is also reported in Table 2. There is a high probability that an individual has a sibling who is depressed and the likelihood of having a cousin who is depressed is fairly similar. The advantage of South Africa's three-generation households (Levetan & Wild 2016) is that depression data for grandparents can also reported. While sample sizes for grandfathers are very small, a third of maternal grandmothers are depressed echoing maternal depression rates above. The chance of living with at least someone in the household who is depressed is 42 percent, showing that overall, depression is unfortunately very common in this sample.

The literature has indicated that there are differences in outcomes for individuals who are depressed and for those who are not depressed. Table 3 presents sample means for individuals who are depressed and those who are not depressed between the ages of 15 and 50 in Waves 1 to 5, with significant differences marked with stars. It is striking that the vast majority of characteristics do differ by depression status and overall, there are stark differences between individuals who are depressed and those who are not depressed, and majority of these factors are highly significant. This means that depression is highly correlated for certain factors, and has a significant difference in certain outcomes.

It is clear that depression is more prevalent among Black/African individuals, women and older individuals. This means that socioeconomic status is associated and correlated with depression. It shows that older Black/African women could be a proxy for depression status. Physical and mental health are also correlated and it is clear that there is a strong correlation between parental and individual mental health.

One in four individuals are depressed, while 54 percent of individuals who identify as female are depressed. Approximately half of this sample have mothers who are depressed with only 42 percent of those mothers being resident in the household. For those who are depressed, maternal poor health differs significantly to those who are not depressed.

While 24 percent of individuals in the sample have depressed fathers, paternal characteristics differ slightly given father's age and whether the father is employed or not. Household characteristics do not differ much and 43 percent of individuals reside in rural areas with an average household size of 5 people. Household grant income does not differ significantly across depressed and non-depressed individuals.

3.3 Center for Epidemiological Studies Depression 10-item Scale

The most common reference for poor mental health diagnosis for empirical work performed by professionals in psychiatry or psychology is the Diagnostic and Statistical Manual-V (DSM-V) (American Psychiatric Association 2013). However, in survey field work, it is necessary to have simple psychometric scales which can be easily administered by lay-person fieldworkers.

In the NIDS, the Center for Epidemiological Studies Short Depression Scale (CES-D 10) is used to measure emotional health (Chinhema et al. 2016). The CES-D asks for the presence and frequency of symptoms and emotional states in the week before the interview including depressive mood, feelings of guilt or worthlessness, sleep disorders and

self-doubt (Radloff 1977).

The CES-D 10-item scale is the shortened version of the longer 20-item scale (Zhang et al. 2012). It is a self-reported measure of depression that is designed as a screening instrument to classify the presence of depressive symptoms in the general population (Radloff 1977). While it is a screening instrument to indicate the presence of depressive symptoms, and not a replacement for a clinical diagnosis, the CES-D 10 is widely used successfully in many low-income Sub-Saharan and Middle-Eastern countries such as Kenya and Iran. (Khamseh et al. 2011, Kilburn et al. 2016, James et al. 2020, Eyal & Burns 2019). It is internally consistent (Hamad et al. 2008) and is a valid and reliable screening tool with good psychometric properties for measuring depression in in three of South Africa's most spoken languages, isiZulu, isiXhosa and Afrikaans-speaking populations (Baron et al. 2017), as well as in English.

The CES-D 10 comprises of ten questions with four possible answers referencing emotional and mental health-related behaviours (Lester & Akande 1997). The questions are rated on a scale of one to four including the frequency in the past week that the person has experienced the symptom, ranging from (1) none of the time (less than one day), (2) some or a little of the time (one to two days), (3) occasionally or a moderate amount of the time (three to four days), to (4) all of the time (five to seven days). The self-reported questions include, 1) I was bothered by things that usually don't bother me, 2) I had trouble keeping my mind on what I was doing, 3) I felt depressed, 4) I felt that everything I did was an effort, 5) I felt hopeful about the future, 6) I felt fearful, 7) My sleep was restless, 8) I was happy, 9) I felt lonely and 10) I could not get going.

Table 2: CES-D Scale Items and Responses across all NIDS Waves

CES-D items on scale	Response	Mean Characteristics									
		Wave 1		Wave 2		Wave 3		Wave 4		Wave 5	
		Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean
1. I was bothered by things that usually don't bother me	< 1 day	79,084	0.29	79,284	0.24	79,584	0.29	79,584	0.27	79,984	0.24
	1-2 days	79,084	0.20	79,084	0.25	79,584	0.20	79,584	0.22	79,084	0.25
	3-4 days	78, 789	0.21	78, 789	0.21	79,584	0.21	79,584	0.21	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	79,584	0.30	79,584	0.30	78,789	0.30
2. I had trouble keeping my mind on what I was doing	< 1 day	79,084	0.35	79,084	0.33	79,584	0.27	79,084	0.24	79,084	0.29
	1-2 days	79,084	0.20	79,084	0.29	79,084	0.22	79,084	0.25	79,084	0.20
	3-4 days	78, 789	0.16	78, 789	0.18	78, 789	0.21	78, 789	0.21	78, 789	0.21
	5-7 days	78,789	0.29	78,789	0.20	78,789	0.30	78,789	0.30	78,789	0.31
3. I felt that everything I did was an effort	< 1 day	79,084	0.24	79,084	0.29	79,084	0.35	79,084	0.27	79,084	0.24
	1-2 days	79,084	0.25	79,084	0.20	79,084	0.20	79,084	0.22	79,084	0.25
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.16	78, 789	0.21	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.29	78,789	0.30	78,789	0.30
4. I felt depressed	< 1 day	79,084	0.29	79,084	0.27	79,084	0.24	79,084	0.29	79,084	0.24
	1-2 days	79,084	0.20	79,084	0.22	79,084	0.25	79,084	0.20	79,084	0.25
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30
5. I felt hopeful about the future*	< 1 day	79,084	0.27	79,084	0.35	79,084	0.29	79,084	0.29	79,084	0.29
	1-2 days	79,084	0.22	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.20
	3-4 days	78, 789	0.21	78, 789	0.16	78, 789	0.21	78, 789	0.21	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.29	78,789	0.30	78,789	0.30	78,789	0.30
6. I felt fearful	< 1 day	79,084	0.24	79,084	0.29	79,084	0.29	79,084	0.35	79,084	0.29
	1-2 days	79,084	0.25	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.20
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.16	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.29	78,789	0.30
7. My sleep was restless	< 1 day	79,084	0.29	79,084	0.29	79,084	0.29	79,084	0.27	79,084	0.29
	1-2 days	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.22	79,084	0.20
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.24
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30
8. I was happy*	< 1 day	79,084	0.29	79,084	0.29	79,084	0.29	79,084	0.29	79,084	0.29
	1-2 days	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.20
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.24	78, 789	0.21	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30
9. I felt lonely	< 1 day	79,084	0.27	79,084	0.29	79,084	0.29	79,084	0.29	79,084	0.29
	1-2 days	79,084	0.22	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.20
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.22	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30
10. I could not get going	< 1 day	79,084	0.29	79,084	0.29	79,084	0.29	79,084	0.27	79,084	0.29
	1-2 days	79,084	0.20	79,084	0.20	79,084	0.20	79,084	0.22	79,084	0.20
	3-4 days	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.21	78, 789	0.21
	5-7 days	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30	78,789	0.30

This table presents mean values of the CES-D item responses using a sample of individuals aged fifteen to fifty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. *Items were reverse coded for the CES-D 8-item scale.

The two positively phrased question, numbers (5) and (8), are inverted, and a score is calculated which sums the answers for each of the ten questions. The number of times these behaviours have been experienced by an individual in the past week are then re-scaled from zero to three, and final scores range from 0 to 30. A score greater than 10 is indicative of symptoms associated with mild to severe depression (Radloff 1977). The CES-D-10 has demonstrated adequate reliability and validity, with good internal consistency (Cronbach's aplha of 0.89) (Björgvinsson et al. 2013).

Figure 1: Depression (CES-D 10) by Age

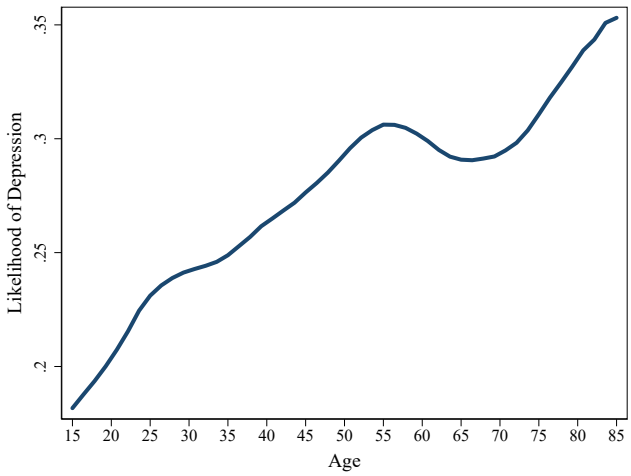


Figure 1 shows the distribution of the likelihood of depression for individuals in the NIDS Waves 1 to 5 given age. The upward pattern indicates that, depression increases with age.

The CES–D has been found to provide more information regarding the severity of depression and, it's properties have also been compared to the Patient Health Questionnaire (PHQ-9), a depression screening tool also validated in South Africa (Engel et al. 2020, Baron et al. 2017). The Brief Symptom Inventory and the Child Depression Rating Scale are among other self-reported scales cited in much of the literature measuring depression (Derogatis & Melisaratos 1983, Khamseh et al. 2011, Choi et al. 2014, Nwosu & Oyenubi 2021, Poznanski et al. 1984). The CES-D 10 replaced the 12-item General Health Questionnaire which was previously in the NIDS as it was found to be too tightly focused on psychiatric categories rather than measuring general mental state (Leibbrandt et al. 2009).

A few studies have since focused on the diagnostic validity of the CES-D-10 in the United States and in China, and cut-offs varied from 8 to scores as high as 16. To classify more severe of depressive symptoms, CES-D 10 cut-off scores of 12 or more have been implemented in a number of studies (Irwin et al. 1999, Lee & Chokkanathan 2008, Björgvinsson et al. 2013, Andresen et al. 1994, Boey 1999, Vilagut et al. 2016). A cut-off of 11, 12 and 13 for Zulu, Afrikaans, Zulu and Xhosa speaking populations, respectively, has also been found to have the most predictive value (Baron et al. 2017). Cut-offs greater than 12 appropriately indicate high to severe risk of depressive symptoms in the South African context given the CES-D 10's sensitivity and specificity across all three major language groups (James et al. 2020, Cheng & Chan 2005).

Another advantage of the CES-D 10 score is that it only asks questions about mental health without explicitly mentioning the names of any psychiatric illnesses (Sorsdahl & Stein 2010). This is important in the South African context where high levels of stigma surrounding mental illness exist in many communities (Masenya et al. 2017, Hugo et al. 2003). While there is no significant difference in characteristics of respondents who answered and those who did not answer the ten component questions, those who did not answer are slightly more likely to be Black/African (Eyal & Burns 2019).

The NIDS also contains other questions about the presence of other psychiatric illnesses such as anxiety, bipolar, and schizo-affective disorder. However, the average response rate for the psychiatric illness questions is relatively low (Eyal & Burns 2019). In contrast to the CES-D 10 questions, only 78 individuals out of more than 25,000 possible respondents reported having a psychological or psychiatric disorder. Similarly, in the 2012 General Household Survey, less than 10 percent of the sample answered the mental health question (Ncitakalo et al. 2019). Of those who did answer the question, only 127 out of a sample of 90,000 reported suffering from poor mental health (Eyal & Burns 2019).

Using research from a paper by Garman et al. (2021), the two positively-worded items

("I was happy" and "I felt hopeful about the future") were not congruent with the other negatively-worded items (Garman et al. 2022). For the CES-D 8, these two items are thus excluded from the score. Using the same data collected by Baron et al. (2017), the optimal cut-off score indicating high risk for a major depressive disorder using the CES-D 8 was 8 for 15 to 24 year olds and 9 for adults (Baron et al. 2017). The 8-item version has an internal consistency of 0.71–0.78 (Garman et al. 2022).

Similarly, figure 6 in the Appendix (A.3) shows the distribution of the likelihood of depression based on the CES-D 8 score in the NIDS Waves 1 to 5 given age. The upward pattern indicates that, depression increases with age. This paper will make use of the CES-D 8-item scale alongside the CES-D 10 to further validate the effects of depression. For the remainder of this paper, the terms depression or depressed are used to indicate that the individual has a CES-D 10 score of 10 or above (or a CES-D 8 score of 8 or above), as opposed to the general interpretation that this is an indication of an individual suffering from depressive symptoms.

Table 3: Mean Depression Characteristics of the Family across NIDS Waves

Mean Mental Health Characteristics of the Family					
	Mean				
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
CES-D 8 Score	4.40	4.29	4.40	4.38	4.42
Depressed (CES-D 8 ≥ 8)	0.20	0.21	0.20	0.22	0.20
CES-D 10 Score	6.91	6.91	6.81	6.91	6.95
Depressed (CES-D 10 ≥ 10)	0.25	0.25	0.25	0.25	0.25
Depressed (CES-D 10 ≥ 12)	0.15	0.14	0.15	0.16	0.15
Depressed (CES-D 10 ≥ 16)	0.04	0.05	0.04	0.03	0.04
Mother CES-D 8 Score	4.82	4.83	4.82	4.84	4.83
Mother is Depressed (CES-D 8 ≥ 8)	0.24	0.21	0.24	0.24	0.24
Mother CES-D 10 score	7.42	7.42	7.42	7.42	7.40
Mother is Depressed (CES-D 10 ≥ 10)	0.29	0.29	0.29	0.30	0.29
Mother is Depressed (CES-D 10 ≥ 12)	0.16	0.15	0.10	0.15	0.15
Mother is Depressed (CES-D 10 ≥ 16)	0.04	0.01	0.04	0.02	0.04
Father CES-D 10 Score	6.78	6.78	6.80	6.78	6.70
Father is Depressed (CES-D 10 ≥ 10)	0.24	0.23	0.24	0.22	0.24
Sibling is Depressed in HH	0.15	0.15	0.16	0.15	0.15
Grandmother is Depressed in HH	0.33	0.32	0.32	0.31	0.32
Grandfather is Depressed in HH	0.38	0.36	0.38	0.39	0.38
Cousin is Depressed in HH	0.11	0.12	0.11	0.13	0.11
Number of Depressed Women in HH	0.46	0.48	0.46	0.46	0.47

This table presents mean values of family mental health characteristics using a sample of individuals aged fifteen to fifty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in 2015 rands.

In Table 3, it is clear that there is strong correlation of mental illness within families - if an individual is depressed, there is a higher likelihood of observing that other members in the family are also depressed. There is as strong relationship between individuals who share an environment in the same family connection or household.

There are significant differences in average familial depression for individuals who are depressed and for individuals who are not depressed, where 14 percent of individuals have a depressed sibling and 34 percent have a depressed maternal grandmother in the household. For those who are depressed, 31 percent have a depressed sibling compared to only 10 percent of those who are not depressed. Similarly for those who have depressed maternal grandmothers, 58 percent are depressed compared to 28 percent who are not depressed. Overall, 43 percent of individuals have a depressed woman resident in their household, and 23 percent of those who are depressed have a depressed cousin.

It is important to note that the individual characteristics described in Table 3 such as age, gender, race are calculated using the full sample of 69,026 (individuals with depression data available). However for all maternal or paternal characteristics, this is a different sample including only those who have data on all depression characteristics because their mothers or fathers are resident. This means that in Table 3, the average age of 33.2 years in the sample was calculated for the 69,026 observations.

However, the average rate for a mother who is depressed according to a CES-D 10 score of 10 or above (32 percent), is calculated as the average residence rate of these 69,026 observations in Table 3. As only 43 and 31 percent of mothers and fathers are resident in the household (see Table 3), these sample sizes are reduced to 29,681 and 21,398,[5] respectively. It is interesting to note that household characteristics such as household grant income and living in a rural area hardly differ by depression status. However, a father's employment does not differ by depression status, and whether either parent is resident also does not differ by depression status. This may be because for the average age in our sample of 33.2 years, many individuals are more independent and are less likely to reside with their parents.

The literature indicates that individual depression is correlated with a number of important characteristics, a phenomenon present in the sample in Table 3 above. This hypothesis is tested again in Table 4, where key variables are assessed for significant differences across parental depression status for Black/African individuals.

[5]Author's own calculations.

Table 4: Mean Individual Characteristics by Depression Status

Mean Characteristics of Individual Depression				
	All	Depressed		Not Depressed
Depressed (CES-D 10 ≥ 10)	0.25	1.00	***	0.00
Deoressed (CES-D 8 ≥ 8)	0.20	0.74	***	0.03
CES-D 8 Score	4.39	9.63	***	2.67
CES-D 10 Score	6.92	12.7	***	4.85
Black/African	0.82	0.89	**	0.86
Coloured	0.09	0.08		0.09
Age	36.7	27.6	***	25.9
Female	0.52	0.54	**	0.51
Education	10.3	10.1	***	10.4
Poor Health	0.11	0.18	**	0.09
Ever Had Still-born Child	0.59	0.54	***	0.60
Mother CES-D 8 Score	5.11	5.11	***	4.43
Mother is Depressed (CES-D 8 ≥ 8)	0.26	0.49	***	0.19
Mother CES-D 10 Score	7.81	10.53	***	7.04
Mother is Depressed (CES-D 10 ≥ 10)	0.32	0.59	***	0.24
Mother is Depressed (CES-D 10 ≥ 12)	0.20	0.41	***	0.13
Mother is Depressed (CES-D 10 ≥ 16)	0.06	0.13	***	0.04
Mother is in Poor Health	0.23	0.26	**	0.23
Mother Ever Had Still-born Child	0.59	0.54	***	0.60
Mother's Age	52.8	54.0	***	52.4
Mother's Education	8.36	7.98	***	8.46
Mother is Employed	0.26	0.23	***	0.27
Mother is Resident	0.43	0.42		0.43
Father CES-D 10 Score	6.89	9.43	***	6.22
Father is Depressed (CES-D 10 ≥ 10)	0.24	0.47	***	0.18
Father's Age	55.5	56.1	*	55.4
Father's Education	8.52	8.24	*	8.59
Father is Employed	0.38	0.38		0.38
Father is Resident	0.31	0.30		0.30
Has a Depressed Sibling in HH	0.14	0.31	***	0.10
Has a Depressed Grandmother in HH	0.34	0.58	***	0.28
Has a Depressed Grandfather in HH	0.34	0.73	*	0.27
Has a Depressed Cousin in HH	0.11	0.23	***	0.08
Number of Depressed Women in HH	0.43	1.19	***	0.19
Household Size	4.80	5.73		5.53
Household Grant Income	1,468	1,472		1,467
Household is in Rural Area	0.43	0.42		0.43
Number of Observations	69,026	16,725		52,301

This table presents mean values and significance tests of differences in individual and household characteristics between individuals who are depressed and individuals who are not depressed, using a sample of individuals aged fifteen to fifty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in 2015 rands. Significant differences are starred. * implies p value < 0.10, ** implies p value <0.05, and *** implies p value < 0.01.

Having investigated differences across individual depression status, Table 4 presents a focus on the intergenerational transmission effect as well the determinants of transmission.

For the remainder of the analysis, the Black/African sample restricted to age 15 to 50 will be used as it represents a population with similar mental health and socioeconomic profiles, with higher rates of mental illness compared to the other race groups (In Table 4, of depressed individuals, 87 percent are Black/African). This sample of individuals have been found to show the worst rates of depression among all other population groups (Eyal & Burns 2019), and a sample showing the same outcomes for Coloured individuals is included in the Appendix (see item A.1). Given that these samples include individuals who are usually among the poorer population groups in South Africa, whether grant income is received or not is more salient and was chosen as the income measure for analysis.

The mean characteristics of parental depression status for Black/African individuals have outcomes similar to Table 3 and similarly, household characteristics hardly differ by depression status. In Table 4, the sample is much larger, and has higher depression rates and household grant income compared to individuals in the sample of Coloured individuals (see item A.1 in the Appendix). Overall, 23 percent of individuals in the sample report suffering from depression, and 6 percent are more severely depressed according to a CES-D 10 cut off of 16 or above - as is the case in Table 3.

Average depression is 41 percent if an individual has a depressed mother and this differs significantly to those who are depressed but do not have a depressed mother (14 percent). Those who have a depressed mother have an average household size of 6 people, which is as large as expected. Household grant income is slightly less than in the full sample in Table 3 and is R1,481. For households with a father resident, the average household grant income is slightly higher at R1,496.

The Coloured population is fairly similar in characteristics to African individuals (see Appendix Item A.1). While education differs significantly between those who have a mother

depressed and those who do not for the Black/African sample, in the Coloured sample, education does not differ much between those who have depressed parents or not. However, the sample size for this group is much smaller and thus is not included in the analysis.

Table 5: Mean Characteristics by Parental Depression for Black/African Individuals

Mean Characteristics of Parental Depression for Black/African Individuals								
	All	Mother is Depressed		Mother is Not Depressed	All	Father is Depressed		Father is Not Depressed
CES-D 8 Score	4.15	5.81	***	3.35	4.10	5.77	***	3.53
Depressed (CES-D 8 ≥ 8)	0.18	0.33	***	0.11	0.17	0.34	***	0.11
CES-D 10 Score	6.68	8.56	***	5.77	6.59	8.60	***	5.90
Depressed (CES-D 10 ≥ 10)	0.23	0.41	***	0.14	0.21	0.40	***	0.15
Depressed (CES-D 10 ≥ 12)	0.13	0.25	***	0.07	0.13	0.28	***	0.08
Depressed (CES-D 10 ≥ 16)	0.03	0.06	***	0.20	0.03	0.07	***	0.02
Age	25.3	25.6	**	25.1	24.3	24.6		24.1
Female	0.51	0.51		0.50	0.49	0.50		0.49
Education	10.4	10.2	***	10.4	10.5	10.4		10.5
Poor Health	0.05	0.06	***	0.05	0.05	0.04		0.05
Mother CES-D 10 Score	8.03	13.01	***	5.54	7.37	10.2	***	6.50
Mother is Depressed (CES-D 10 ≥ 10)	0.33	1.00	***	0.00	0.28	0.59	***	0.19
Mother is in Poor Health	0.40	0.32	***	0.21	0.20	0.28	***	0.18
Mother Ever Had Still-born	0.54	0.51	***	0.57	0.61	0.58		0.62
Mother's Age	52.8	53.3	**	52.6	51.2	52.2	**	50.9
Mother Education	8.13	7.70	***	8.34	8.40	7.96	***	8.53
Mother is Employed	0.25	0.21	***	0.27	0.26	0.25		0.27
Father CES-D 10 Score	6.98	9.71	***	5.90	7.12	12.6	***	5.25
Father is Depressed (CES-D 10 ≥ 10)	0.24	0.49	***	0.13	0.25	1.00		0.00
Father's Age	55.9	56.1		55.9	56.9	57.7	*	56.7
Father Education	8.03	7.70	**	8.16	8.05	7.52	**	8.22
Father is Employed	0.34	0.29	**	0.36	0.33	0.26	***	0.35
Household Size	6.04	6.33	**	5.90	6.16	6.32		6.10
Household Grant Income	1,481	1,503		1,469	1,496	1,514		1,490
Household is in a Rural Area	0.48	0.46		0.48	0.45	0.44		0.45
Number of Observations	25,315	8,493		16,822	9,050	2,505		6,545

This table presents mean values and significance tests of differences in individual and household characteristics between individuals who have depressed parents and individuals who do not have depressed parents, using a sample of Black/African individuals aged fifteen to fifty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in 2015 rands. Significant differences are starred. * implies p

The next chapter presents a preliminary data analysis.

4 Preliminary Data Analysis

This section presents a preliminary graphical analysis of depression. Here, the effect that parental depression, age, gender, race and different CES-D cut offs (mentioned in Section 3.2 and 3.3) has on individual depression is presented for a broad sample of individuals

aged 15 to 85.

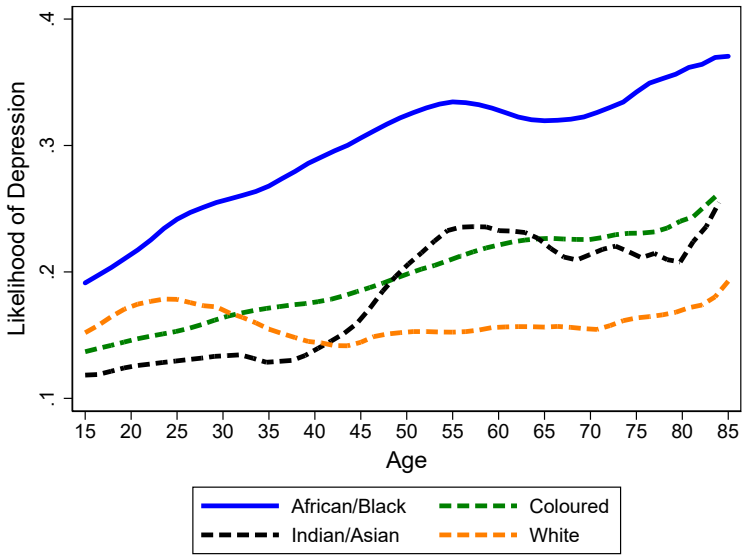
In the literature, there is overwhelming evidence regarding the sizeable effect that a parent's depression has on individual depression. In the rest of this section, Figures 6 onward will present a sample of individuals restricted to individuals aged 50 and younger to further explore the distribution of depression across gender given a parent's depression status or CES-D 10 score. The age restriction of 50 and younger allows for the distribution to only represent those who are more likely to have mothers and fathers who are still alive. All figures make use of local polynomial estimation with the epanechnikov kernel (Cameron & Trivedi 2009), which allows for the most unrestricted estimation of the relationship between the dependent and independent variables in each figure.

4.1 Graphic Analysis

In the literature, poor mental health is reported to differ across a number of different demographic variables including age (as seen in Figure 1 and 2 in Section 3). Figure 3 shows depression based on the CES-D 10 over age for all population groups in South Africa. Compared to all the other samples, the African/Black sample shows much higher rates of depression than any other population group. Only 12 percent of White 35 year olds are depressed, compared to 27 percent of African individuals of the same age.

Given small sample sizes in the White and Indian/Asian individuals in the NIDS, the distributions are hardly definitive. Indian/Asian individuals have a sudden increase in rates of depression however, it is not clear whether this is a pattern which applies for all Indian/Asian South Africans given the small sample size of this group. Although the same applies for White individuals, there is a sharp increase in depression rates around the age of 25. These rates of depression are nearly matched to rates of Black/African individuals of the same age and are between 20 and 25 percent.

Figure 2: The Likelihood of Depression given Age and Race



In Figure 2, while there is an expected upward trend of depression as individuals age, the African/Black sample has significantly higher levels of depression. A similar distribution is seen in Figure 1 where rates of depression increase over age, although there are much higher rates for Black/African individuals where 30 percent of 45 year olds are depressed compared to only 18 percent of Coloured individuals of the same age.

The Black/African sample represents 82 percent of the entire NIDS sample due to the structure of the South African population. In 2021, of the total South African population at the time, 81 percent declared themselves to be Black/African, while 8 percent identified as White, 9 percent as Coloured and 3 percent as Indian/Asian (Hirschowitz 2021). As such, this serves as further justification that the remainder of this thesis will continue to focus on this sample of Black/African individuals.

While a CES-D 10 score of 10 or above (or a CES-D 8 score of 8 or above) indicates depression, Figure 5 presents rates of depression across all ages for a CES-D 10 score cut off of 12 or above. In the literature, a cut off of 12 subsequently indicates severe depression (Lee & Chokkanathan 2008, Andresen et al. 1994, Vilagut et al. 2016, Radloff 1977).

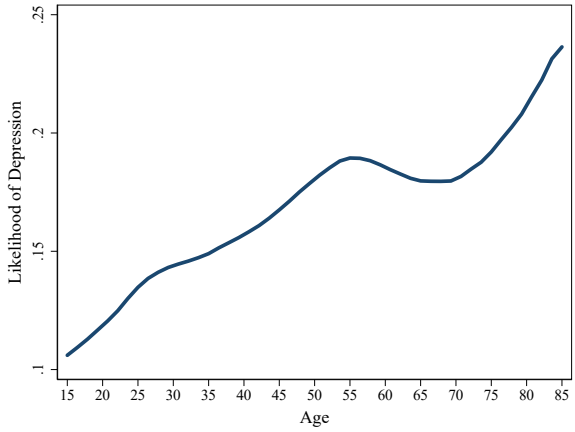
Severe depression is also found to increase with age - this is similar to the distribution of

depression based on the original CES-D 10 score cut off of 10 or above observed in Figure 1 of Section 3.2. Rates of depression are obviously much lower when classified with stricter definitions, for example, 17 percent of 50 year olds suffer from severe depression given a CESD-10 score of 12 or above, and much lower rates are observe where 0.06 percent of 50 years olds are even more severely depressed (CESD-10 $\geq$ 16). See Figure 9 in A.4 of the appendix.

The patterns of more severe depression are similar to those presented in Figure 1 (Section 3.2), with a similar increase in depression over the age distribution which appears to decrease sharply at a point for all measures at approximately age 55. Rates of depression then increases from the age 70. It is worth noting the high variability present in depression for those aged 70 and above, as this sample is much smaller. Thus the sharp increase in depression from age 70 is not the main focus, but rather the gradual increase and decline over the younger cohort in the sample.

Figure 3: The Likelihood of Depression given CES-D 10 scores $\geq$ 12

3(a). CES-D 10 $\geq$ 12



3(b). CES-D 10 CES-D 10 $\geq$ 16

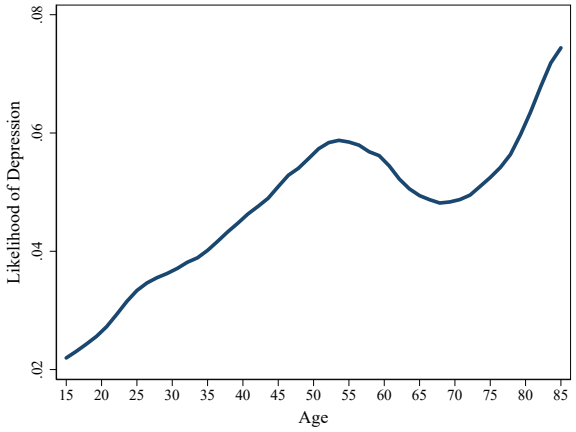
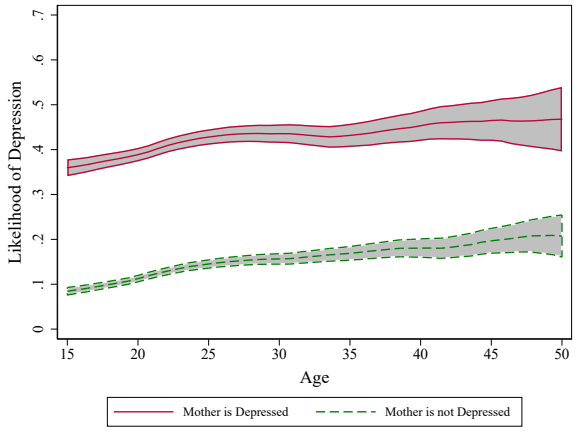


Figure 3 shows the likelihood of depression for individuals who have CES-D 10 scores $\geq$ 12. Source: NIDS Waves 1 to 5.

Figure 4: Intergenerational Transmission: Maternal

4(a). CES-D 10



4(b). CES-D 8

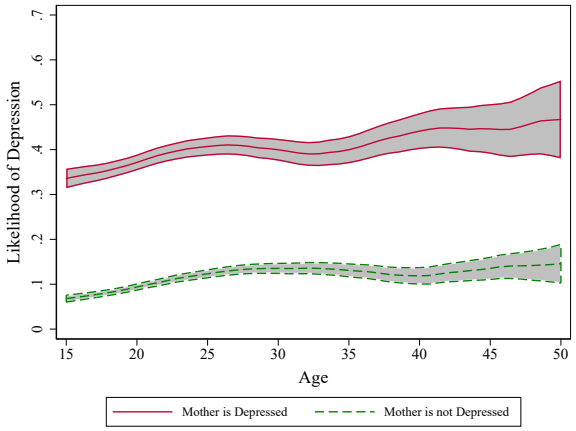


Figure 4 shows the likelihood of depression for individuals who have depressed mothers. 95% confidence intervals are shown. Source: NIDS Waves 1 to 5.

Parental Depression, specifically maternal depression, has been cited in the literature as the single largest determinant of individual depression. In the figures above, rates of individual depression based on both CES-D scales increase as maternal depression increases. The rates of depression for those with a depressed mother are approximately 30 percent higher than rates of those who do not have depressed mothers across all ages and for both CES-D scales used to measure depression.

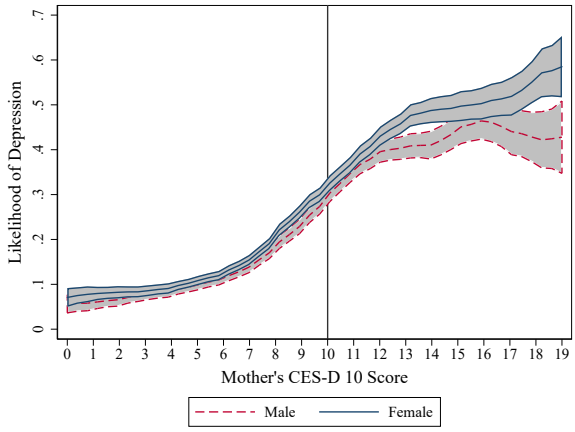
While there is an upward trend of individual depression given a resident father being depressed in the household as seen in Figure 7a and 7b below, there is much variation in paternal depression as there are far fewer fathers resident in households.

In the NIDS Waves 1 to 5, only 32 percent of fathers are resident in the household and depression is only recorded for fathers who were resident at the time of the survey. In a household where a mother is also resident, paternal residence is slightly higher at 48 percent. These low paternal residence rates are not surprising as in a country like South Africa where levels of paternal absence are particularly high in comparison of estimates of similar countries in sub-Saharan Africa (Posel & Devey 2006). This means we cannot accurately or definitively infer much regarding the relationship between individual depression and having a father who may be depressed resident in the household given these low

residence rates.

Figure 5: Intergenerational Transmission by Gender from Either Parent (CES-D 10 $\geq$ 10)

5(a). Maternal CES-D 10



5(b). Paternal CES-D 10

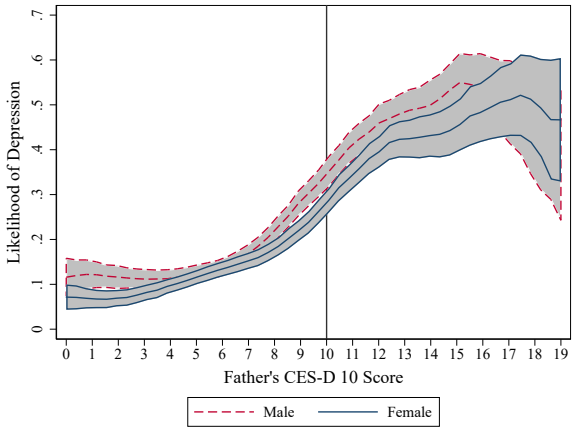


Figure 5 shows the likelihood of depression for individuals who have depressed fathers. 95% confidence intervals are shown. Source: NIDS Waves 1 to 5.

In Figure 5 above, rates of depression are seen to increase with parental CES-D 10 score, and rates are much higher for those who identify as female. This further confirms the large and positive relationship between parental mental health and individual depression, particularly for women cited widely in the literature (Ardington & Case 2009). For maternal scores greater than or equal to 10, those who identify as female also have higher rates of depression than those who identify as male, and the same is true for paternal CES-D scores.

A parental CES-D 10 score greater than 12 is indicative of more severe depression for parents. This relationship between individual depression and parental CES-D 10 score is investigated further. Figure 9a and 9b indicate that severe depression with cut-offs of 12 or above, also indicate that for severe parental depression, individual depression rates are much higher, particularly for women.

As expected, we observe that rates of depression for those with more severely depressed mothers (indicated by cut off scores of 16 or above) are also significantly higher for those who identify as female than for those who identify as male. See Appendix A.4 for parental

CES-D cut offs at a score of 10 and above. Specifically, in Figure 9c, the gender differences become very clear at a maternal CES-D 10 score of 16 or above. Similar patterns are evident with paternal CES-D 10 score, although significant differences by gender are not as definitive due to low paternal residence sample sizes (Eyal & Burns 2019).

For the main analysis in this paper, the sample chosen is those aged 15 to 50. The lower end of this age range is due to the CES-D 10 score only collected for those aged fifteen and above. The upper age limit chosen reflects the falling probability that an individual lives with their parent the older they are. This assumption is borne out in the data. The average age of those individuals with mothers not resident in the household is 34 years of age, while those with mothers resident is 25 years.[6] The corresponding figures for paternal absence and presence are 28 and 24 years of age. More than 99 percent of the sample who live with their mothers or fathers are aged 60 or below.

Following the graphical analysis, a full sample of individuals aged 15 to 50 is explored in the descriptive statistics, while the regression analysis in Chapter 5 also uses this full sample for reasons explained previously. To measure intergenerational transmission in Chapter 6, a smaller sample with an even lower age restriction of 35 will be used to represent those who would most likely have parents who are still alive and resident in previous and current waves of the NIDS Waves 1 to 5.

5 Causality in the Intergenerational Transmission of Depression

For the reader's convenience, Equation 1 (Akbulut & Kugler 2007), which models intergenerational transmission is repeated below,

$$MH_i = f(X_i, HH_i, C_c, P_p, PD_p) \tag{2}$$

[6] Authors own calculations

This paper assumes C_c factors are analogous with HH_i factors where household and environmental factors such as household income, location, size, over household age and employment, whether the household has experienced any income shocks or deaths recently, as well as the overall health and mental health across all household members are considered. As in Equation 1, PD_p refers to the parents depression which captures the basis of this paper, and the level of strength of this factor refers to the level in which mental health is transmitted from parent to child (Eyal et al. 2018).

Given that only 31 percent of fathers are resident in the household as seen in Table 3, in Table 5, sample sizes drops considerably in Column 1 compared to Column 2 due to this low paternal residence. This is not surprising in a country like South Africa where according to Statistics South Africa (2021), over two thirds of children live in households without their biological fathers (Hirschowitz 2021). In Table 2, for those who have a mother resident in the household, paternal residence is also quite low at 48 percent (compared to close to 80 percent of mothers being resident if a father is also resident).

As mentioned previously, a sample of individuals aged 15 to 50 was explored in the descriptive statistics between individual and parental characteristics for reasons explained previously. Throughout the rest of Chapter 5, the regression analysis also uses this full sample. To measure intergenerational transmission further in Chapter 6, a smaller sample with an even lower age restriction of 35 will be used to represent those who would most likely have parents who are still alive or resident in previous and current waves of the NIDS Waves 1 to 5.

5.1 Estimating Intergenerational Transmission

In this section, the conditional and unconditional impact of parental depression on individual depression is examined. First, the impact of parental depression on individual depression will be examined. Second, the impact of parental depression whilst considering other individual, household and other parental characteristics will be examined.

The impact of parental depression is considered including individual, household and parental characteristics as explained above for Equation 1. A number of robustness checks will also be performed to further examine maternal depression's effect on individual depression. Finally, the exogeneity of maternal depression will be explored using an instrumental variable approach.

The aim of this chapter is to attempt to estimate a causal effect. For instance, estimates in Table 6, while including potential determinants of individual depression make it more likely that the effect is causal, it cannot be assumed that these estimates do not represent simple correlations. As such, we continue to investigate these estimates further in Section 5.2 which follows this section.

Table 6 presents ordinary least square (OLS) estimates of Equation 1 and 2 above. Throughout the regression analysis, where appropriate, robust standard errors are corrected for heteroskedasticity and clustered at the PID individual level. Columns 1 to 5 show the effect of maternal and paternal depression on individual depression. Column 1 shows the maternal depression's effect on individual depression excluding any control variables and, at approximately 28 percentage points, the size of the effect is large and highly significant at the one percent level.

Including parental depression for both parents eliminates omitted variable bias (arising from excluding the other parent's mental health status), and allows a focused analysis of the impact of parental depression in nuclear families, as opposed to analysis in a more heterogeneous sample where the other parent may or may not be resident.

The associations found between parental and individual depression in Table 6 are sizable. An individual's probability of exhibiting similar symptoms is close to 30 percentage points higher. This is a substantial effect given that 25 percent of the sample is found to suffer from depression in the sample. Similar size transmission coefficients are seen in

the sample estimating the paternal transmission of depression. These effects are robust to the inclusion or exclusion of different control variables such as binary variables of wave and province.

Unconditional estimates in Column 1 and Column 2 show the effect of a mother including paternal residence excluding any control variables and at a coefficient of 28 percentage points, the size of this effect is very large. In Column 3, the joint effect of both parents depression is examined. Columns 4 and 5 include controls indicated according to the literature on the determinants of transmission. The coefficient sizes remains large at approximately 19 and 20 percentage points, for mothers and fathers respectively. The intergenerational transmission effect is the largest compared to all other determinants of individual depression, and these parental transmission effects are comparable in size.

Table 6: Estimating Individual Depression

The Effect of Parental Depression on Individual Depression				
	Individual is Depressed (CES-D 10 ≥ 10)			
	(1)	(2)	(3)	(4)
Mother is Depressed	0.28***		0.19***	0.27***
Father is Depressed		0.28***	0.21***	
Age				0.01***
Female				0.02*
Education				0.00
Employed				-0.03*
Mother is Employed				0.02
Father is Resident				0.01
Household Size				0.00*
Log Household Grant Income				-0.02***
Household in a Rural Area				-0.01
Wave 2				-0.00
Wave 3				0.02
Wave 4				-0.01
Wave 5				0.01
Eastern Cape				-0.13***
Northern Cape				-0.15***
Free State				-0.16***
Kwa-Zulu Natal				-0.13***
North West				-0.14***
Gauteng				-0.10**
Mpumalanga				-0.18**
Limpopo				-0.17***
Number of Observations	21,939	7,858	6,261	17,294

Ordinary least squares estimates are estimated to measure the impact of parental depression on an individual's depression controlling for individual, parental and household characteristics. All wave and province dummies are included in column (5). The base sample consists of Black/African depressed individuals between the ages of fifteen and fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

Following the literature, for those identifying as female, higher levels of depression are observed than for those who identify as males in Column 4. However, this effect is weakened by the inclusion of other relevant determinants of depression in Column 5. Employment is a protective factor for mental health, reducing probability of depression by up to 5 percentage points in Columns 5 and 6. An increase in household grant income lowers the probability of suffering from depression.[7]

While the effect of any parent's depression on individual depression is robust to additional control variables, all province indicators are large and significant and compared to all other provinces, mental health is significantly better in the base province of Western Cape. This may be due to higher incomes observed in this province. The decreasing sample sizes from Columns 1 to 5, indicate the previously discussed availability of depression data as well as the lower rates of paternal residency in the sample. These results are similar to the unconditional results shown in Table 3 of Section 4.2.

In the next section, robustness checks are performed to explore any potentially confounding factors and the sensitivity of the results above.

5.2 Robustness Checks

To determine the sensitivity and underlying effects of the results shown in Table 6, a number of robustness checks will be discussed in this section.

5.2.1 Alternate Specifications

Table 6 has shown that in general individual depression increases with parental depression regardless of the inclusion of additional controls. Table 7 presents alternate specifications to the OLS estimates used in Table 6. Given the binary nature of the depression variable, it is appropriate to also consider probit and logit estimates for comparability. To exploit

[7]This effect size is fairly large (a 1 percent increase in grant income, lowers depression by 1 percentage point), and similar surprising patterns are observed in household income as well(Eyal & Burns 2019). However, household grant income seems to suffer less from this problem of inexplicably large coefficient size and it is more reasonable to include it to lower the risk omitted variable bias than to exclude it given that it is not the main coefficient of interest.

the panel nature of the data used, random effects and fixed effects are also explored in Columns 4 to 6.

Estimates are presented to examine the transmission of depressive symptoms from mothers alone in Column 4 of Table 6. This model is estimated using five different specifications. The size of of the parental effect of depression is large and is between 16 and 22 percentage points, and is highly significant across all specifications. Column 1 presents ordinary least square estimates and Column 2 presents the linear probability model using ordinary least square estimates. Columns 2 and 3 present the non-linear probit and logit average marginal effects and, Column 4 and 5 present individual-level fixed effects including paternal residence and additional controls.

The coefficients on maternal depression for the non-linear probit and logit models are slightly lower than the corresponding coefficients for the other specifications. The size of the effect is approximately 16 percentage points for both parents, and is still highly significant for both the probit and logit models.

It is found that probit models can be expected to generate marginal effects close to ordinary least square estimates when the predicted probabilities are close to 0.5, this is when the conditional expectation function (CEF) is roughly near the middle. Consequently, predictions closer to zero or one present larger gaps in the estimates and it is usually expected that non-linear models may exhibit complexities with panel data (Angrist & Pischke 2008).

The same sentiments can be applied in selecting a specification to measure this transmission effect. It follows that the probit predicted probabilities are similar to the ordinary least squares fitted values for own depression over age. This means that the predicted values of ordinary least square estimates for depression over age do not lie outside the bounds of zero and one.

For ease of comparability with the other literature, fixed effects estimates, which are similar to the ordinary least squares estimates, are used for the remainder of this text.[8].The following results do not differ appreciably when estimated using probit or logit marginal effects.

As seen in Table 6, the addition of additional control variables changes the coefficient size of the effect and significance very little. Having a mother or father who is employed hardly influences an individuals's probability of depression, rather whether they are educated has a significant effect at the 1 percent level. However, the effect of age is practically zero and in the fixed effects specification presented by Column 6, it is clear that the neither parental control variables besides a father's employment, are significant predictors of individual depression. While residing in several provinces listed in Table 7 seems to decrease the effects of depression, no household characteristics are found to have an effect on individual depression.

[8]The model fails the Breusch-Pagan and White tests for heteroskedasticity with the null hypothesis of constant variance rejected at the 1 percent level of significance for both tests. Robust standard errors are used in all specifications to correct for heteroskedasticity (Wooldridge 2015), as is the case for the specifications presented by Columns 1, 2, 3, 4 and 5. The NIDS data takes on a stratified, two-stage cluster sample design and is stratified across district councils (Leibbrandt et al. 2009, Chinhema et al. 2016) which historically emanate from the urban racial segregation that persists (Christopher 2001) in relation to the Group Areas Act No. 41 of 1950 (Horrell & Cillié 1978) This fixed effects model accounts for these within-cluster unobservable factors

Table 7: Specifications to Estimate Individual Depression

Specification: The Effect of Maternal Depresion on Individual Depression						
	Individual is Depressed (CES-D 10 ≥ 10)					
	OLS	Probit	Logit	Random Effects	Fixed Effects	Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)
Mother is Depressed	0.25***	0.20***	0.21***	0.22***	0.26***	0.28***
Age	0.01***	0.01***	0.01***	0.01***	-0.00	-0.00
Female	0.02*	0.02*	0.02*	0.02*		
Education	0.00	0.00	0.00	0.00	0.03***	0.02***
Employed	-0.03*	-0.03*	-0.03*	-0.03*	-0.01	-0.01
Mother is Employed	0.02	0.01	0.02	0.02	0.02	0.02
Father is Resident						-0.05
Household Size	0.00*	0.00*	0.00**	0.00*	-0.00	0.00
Log Household Grant Income	-0.02***	-0.03***	-0.03***	-0.02***	-0.01	-0.01
Rural	-0.01	-0.01	-0.02	-0.02	0.00	0.02
North West	-0.14***	-0.13***	-0.14***	-0.13***	-0.43*	-0.50*
Gauteng	-0.10***	-0.10**	-0.10**	-0.10**	-0.54**	-0.50**
Mpumalanga	-0.18***	-0.18***	-0.18***	-0.18***	-1.00***	-1.00***
Limpopo	-0.17***	-0.17***	-0.17***	-0.16***	-0.70**	-0.65**
Number of Observations	17,294	17,294	17,294	17,294	17,294	17,194
R-squared	0.16				0.16	0.17

(1) Ordinary least squares, (2) probit average marginal effects, (3) logit, (4) random effects, (5) and (6) fixed effects estimates are estimated to measure the impact of maternal depression on an individual's depression controlling for individual, parental and household characteristics including significant province dummies. Other province and wave dummies are included but not reported here. The base sample consists of Black/African depressed individuals between the ages of fifteen and fifty in each wave. *

The next section discusses whether fixed effects are appropriate in determining the effect of the intergenerational transmission effect.

5.2.2 Fixed Effects

The null hypothesis of the Hausman test is that, correcting for variance, estimates do not differ between the two specifications (Amini et al. 2012). Put differently, the null of the Hausman test is that an explanatory variable is exogenous to a corresponding independent variable. In the models presented in Column 5 to 6, we reject the null of the Hausman test and find that parental depression could indeed be endogenous to individual depression and that random effects may not be an appropriate model in determining the transmission of depression.

The direction of causality has been found to run strongly from parent to child (Eyal et al. 2017). In the literature, the language used indicates a causal interpretation of the key coefficients of interest. The causality of maternal depression on individual depression is assumed despite the possible endogeneity of maternal depression in the model. If there are omitted variables, and these variables are correlated with the variables in the model, then fixed effects models may provide a means for controlling for omitted variable bias. Whatever effects the omitted variables (for example, height or any variable which is time-invariant) has at one time on depression, it will also have the same effect at a later time and hence their effects will be constant, or fixed.

Column 4 of Table 6 presents the random effects specification to determine depression. Given that the Hausman rejects the random effects model in favor of a fixed effects as the appropriate model, for the remainder of this paper, fixed effects models to determine the transmission effect will be used.

Very similar results to the linear probability models in Table 5 are found, for the individual fixed effects in Columns 5 and 6. Maternal depression is strongly associated with individual depression and represents an increase in the intergenerational transmission effect. Having included controls, it may be that depression is conditional on these controls. However, the fixed effects estimates which exclude the time effects of these controls report quantitatively similar results as the ordinary least square estimates in Column 1.

In the next section, we explore the literature regarding father involvement in South Africa and also examine whether paternal characteristics are important determinants of the intergenerational transmission of depression.

5.2.3 Does Paternal Depression and Paternal Residence Matter?

To determine whether paternal characteristics are important in determining the intergenerational transmission effect, literature on fatherhood in South Africa is presented. Following this, differences between sample means of individuals with resident fathers and

those with fathers who are not resident will also be examined in Table ?? below.

Paternal involvement in South Africa is low, despite evidence that it can improve maternal and child health and well-being (Drysdale et al. 2021). Further, paternal poor mental health has been linked to adverse effects on maternal mental health and child development resulting in negative socio-emotional, cognitive, physical,and behavioural outcomes particularly in children (Van den Berg & Makusha 2018, Van den Berg & Makusha 2021).

Residency status of fathers refers to whether the child and father live in the same household, or not (Van den Berg & Makusha 2018). The term 'absent father' is used to refer to a father that is neither physically living in the same household as his child, nor involved in the child's life. While the term is often used in research to refer to the absence of a biological father in the household where the child lives, it has also been referred to as a non-biological father being absent (Van den Berg & Makusha 2021).

A father is counted as 'non-resident' by Statistics South Africa when he is away from home for 4 or more days per week (Statistics South Africa 2020). While non-resident fathers may still be involved in a child's life, paternal involvement is used as an overarching term for several categories such as emotional support, communication, financial support and care-giving, among other factors (Van den Berg & Makusha 2018, Van den Berg & Makusha 2021).

Research on the determinants of paternal involvement in South Africa have shown that fatherhood can be a crossroad for many men. It marks the shift from an individualistic perspective of solely caring for individual needs towards a sense of personal responsibility where adequate self-reflection to initiate positive behaviour changes for parenting is imperative (Drysdale et al. 2021). As recent as 2018, the South African General Household Survey showed a decline in the percentage of fathers who stayed with their biological children, with North West presenting the largest percentage point decline of 6 percent between 2014 and 2018. The Western Cape had the highest percentage of homes where

children stayed with their fathers (56 percent), while the Eastern Cape had the lowest percentage at only 25 percent.

The survey also revealed that only a third of Black/African children stayed with their biological fathers, compared to 51 percent of Coloured children, 86 percent of Indian/Asian children and 80 percent of White children. Comparably, across all four race groups, between up to 92 percent of children stayed with their mothers (Statistics South Africa 2020, Maluleke 2021*a*).

Analysis of the first wave of NIDS data (Ardington & Case 2009) also shows that Black/African children had the largest percentage of absent fathers (40 percent). Furthermore, only 27 percent lived with both parents, and 45 percent with their biological mother only (Van den Berg & Makusha 2018, Van den Berg & Makusha 2021). According to the fatherhood characteristics in the General Household Survey 2019, for households with higher income, only 26 percent of children who know their fathers are not living with them compared to 64 percent of children in lower income households. The survey also finds that 9 percent of Black/African children live in lone-parent households as compared to only 4 to 5 percent for children of other races (Van den Berg & Makusha 2021).

In 2020, the National Income Dynamics Study - Coronavirus Rapid Mobile Survey (NIDS-CRAM) found that the percentage of men who lived with children had increased significantly during the COVID-19 pandemic lockdown in South Africa (Daniels et al. 2020). Despite this, South Africa still has very high rates of fathers living separately from their children, with over two thirds of children living in households without their biological fathers (Maluleke 2020, Hirschowitz 2021, Maluleke 2021*a*).

Financial provision remains the most central dimension of fatherhood for many men. Having a job and providing for children are still considered the most honoured forms of masculinity and fatherhood. The post-apartheid period has deepened the dependence on family members for support in poorer communities given higher levels of poverty,

unemployment, and uneven access to social grants (Mosiane 2012, Van den Berg & Makusha 2018, Van den Berg & Makusha 2021). It follows that the reality for many of South Africa's Black/African unemployed men is that, because of their economic circumstances, they experience socioeconomic and cultural barriers that prevent them from engaging their children to be present fathers.

Research has suggested that for many men, the failure to be primary providers is unbearable and results in further neglect of children's needs such as emotional support and care-giving (Hunter 2006). This is central in a context of high unemployment and poverty which make it extremely difficult for men to earn money and occupy this provider and care-giving role (Bank 2001). The frustration of not being able to meet expectations such as building a home and providing for children is especially true for men living in poverty, over and above burdens related to HIV and other illnesses prevalent in the South African context (Van den Berg & Makusha 2018, Van den Berg & Makusha 2021).

Despite attempts in some studies to translate English words describing depression to other South African languages (Bhana et al. 2019, Baron et al. 2017), in isiZulu, for example, there are no definitive words to describe depression and as such, poor mental health is hardly seen as a real illness in many African cultures (Ngcobo & Pillay 2008). As a result, those with poor mental health are at risk of being discriminated against, disowned by their families, or even fired from work, should they admit to having a problem (Van den Berg & Makusha 2021). The perception that someone with a mental illness is "crazy", dangerous, or weak continues to persist in many of these communities and, because there is often an absence of physical symptoms with mental illness, it is often considered as not a real illness, particularly for men (Depression & Anxiety Group 2018).

Fathers in a co-parenting role are found to play a critical role in moderating the relationship between depression in mothers and children's development outcomes (Williams 2018). This may be indirect, as suggested by the finding that adolescent offspring of depressed mothers are more likely to sustain good mental health in the presence of support from

the co-parent (Collishaw et al. 2016). Research has also shown that the mental health of fathers and mothers was modestly correlated, and early paternal depressive symptoms predict worsening maternal depressive symptoms (Paulson et al. 2016, Williams 2018).

To investigate the effects of paternal absence further, Table 7 presents mean characteristics for individuals who have a father resident in the household and those who do not have a father resident in the NIDS Waves 1 to 5, with significant differences marked with stars. It is evident that the vast majority of depression characteristics do not differ by a father's residence in the household and overall, there are hardly any differences for maternal depression and other maternal characteristics for individuals who have a father resident and for those who do not.

While all the household characteristics are highly significant, there a significant differences between a father's age and whether he is employed. These results are expected and are comparable to the literature. This means that paternal residence is significant for household characteristics (the shared family environment), however it is not as important when it comes to individual and depression outcomes.

In Table 7, none of the individual depression characteristics in the fathers resident sample differ significantly from those who do not have a resident father. This sample is clearly different in characteristics to the sample of individuals with a resident mother, although average individual depression is the same in both samples. Furthermore in Column 6 of Table 6, paternal residence is not found to be a significant predictor for individual depression.

An F-test was performed on this model in Column 6 to determine whether paternal residence and paternal depression are jointly significant in the model. As expected, the null that paternal characteristics are not significant predictors in determining individual depression is rejected. However, lower sample sizes and the lack of significant determinants in the sample estimating paternal transmission, are analogous to literature regarding pa-

ternal involvement in South Africa (Powdthavee & Vignoles 2008, Eyal & Burns 2019).

The Developmental Model for Understanding Mechanisms of Transmission identified in Equation 1 and 2 identifies several sets of variables that may exacerbate the association of the intergenerational transmission of depression. Some of these variables included paternal mental health and involvement. Despite this, controlling for whether the a father is resident has very little impact on the size of the transmission effect, nor is this control significant. As mentioned previously, missing data for the father resident indicator lowers the sample size significantly and as such, to determine the intergenerational transmission effect further, we explore maternal depression's effect on depression alone in the sections which follow and particularly in Section 5.3.

Table 8: Mean Characteristics for Paternal Residence

Mean Characteristics of Paternal Residence				
	All	Father is Resident		Father is not Resident
CES-D 8 Score	4.08	3.99		4.11
Depressed (CES-D 8 ≥ 8)	0.18	0.17		0.18
CES-D 10 Score	6.46	6.42		6.48
Depressed (CES-D 10 ≥ 10)	0.21	0.21		0.22
Depressed (CES-D 10 ≥ 12)	0.13	0.13		0.12
Depressed (CES-D 10 ≥ 16)	0.03	0.03		0.03
Black	0.81	0.79		0.82
Coloured	0.10	0.12	**	0.09
Age	27.3	23.1	***	29.2
Female	0.52	0.51		0.52
Education	10.5	10.3	***	10.7
Poor Health	0.05	0.05	*	0.06
Ever Had Still-born	0.89	0.93	***	0.88
Mother CES-D 10 Score	7.49	7.37	*	7.62
Mother is Depressed	0.29	0.28		0.30
Mother's Age	49.7	49.6		49.8
Mother Education	8.72	8.77		8.68
Mother is Employed	0.29	0.29		0.29
Mother is in Poor Health	0.20	0.19		0.22
Father CES-D 10 Score	6.93	7.03	*	6.61
Father is Depressed	0.25	0.25		0.23
Father's Age	55.9	55.2	***	57.9
Father Education	8.50	8.41		8.77
Father is Employed	0.37	0.39	***	0.30
Household Size	5.04	6.68	***	4.31
Household Grant Income	1,337	1,538	***	1,218
Household is in a Rural Area	0.37	0.43	***	0.35
Number of Observations	29,265	9,337		19,928

This table presents mean values and significance tests of differences in individual and household characteristics between individuals who have a father resident in the household and individuals who do not have a father resident, using a sample of individuals aged fifteen to fifty in Waves 1 to 5 of the National

5.2.4 Do Other Genetic Factors Affect Individual Depression?

There are potentially confounding factors regarding whether the effects of maternal depression on individual depression decreases with age, producing a possibility of upward bias in our estimates. In this situation, ordinary least squares produce biased and inconsistent estimates. Explanatory variables that suffer from these issues in the context of a

regression are often referred to as endogenous.

Changes in individual depression which change the coefficient on maternal depression ("reverse" causation), further means there are omitted variables in the model which could affect both the individual and maternal depression. Alternatively, these variables are subject to non-random measurement error, which is unlikely in the NIDS. However, if an instrument is available, consistent estimates may still be obtained. An instrument is a variable that does not itself belong in the explanatory equation but is correlated with the endogenous explanatory variables, conditionally on the value of other covariates. An instrumental variable approach will be explored in Section 5.5.

Given that the effect of maternal depression appears fairly constant over the age distribution (see Chapter 4), in this section, to account for possible omitted variable bias, individual height and maternal height is included in the model to account for genetic factors other than maternal depression.

While maternal depression is the single largest determinant of individual depression in all the models presented Table 8 below, height and maternal height are not found to be a significant predictor of individual depression. The addition of additional controls including height in Columns 2 and 3, hardly change size of the effect of maternal depression on individual depression. Despite a much smaller sample size with the inclusion of wave and province binaries in Column 3, education seems to have a significant effect on individual depression while maternal height and individual height itself are not significant all.

This result further supports the existence of a strong parental depression component in the intergenerational transmission effect. It follows that perhaps a parent's depression is indeed causal to one's own depression. However, this will continue to be investigated throughout this chapter.While issues of causality versus correlation are common, many studies attempt to investigate other characteristics which may be passed from parent to child such as socio-economic status and trust, ability, risk preferences

(Carvalho 2012, Stowasser et al. 2011, Lochner et al. 2008, Dohmen et al. 2012). One of these studies show a positive relationship between trust attitudes of second generation immigrants and current trust attitudes of their parent's country of origin and, while not a direct causal relationship, it is found that the effect is exacerbated by parental attitudes mainly because children of second generation immigrants are unlikely to have had meaningful exposure to their (parent's) country of origin such that it affects their judgement on the country (Guiso et al. 2006). While this literature is interesting and provides other examples of the transmission effect, a key limitation is that it still presents the difficulty of disentangling intergenerational transmission passed on from a parent to a child from straightforward intergenerational correlations between a parent and their child (Fleury & Gilles 2018).

Table 9: Estimating Individual Depression controlling for Height

The Effect of Height and Maternal Height on Individual Depression			
	Individual is Depressed (CES-D 10 ≥ 10)		
	(1)	(2)	(3)
Mother is Depressed	0.27***	0.29***	0.28***
Height	-0.00	-0.00	-0.00
Mother's Height	-0.00	-0.00	0.00
Mortality in the Last 24m		-0.04***	-0.03
Age			0.01
Years of Education			0.03***
Employed			-0.01
Mother is Employed			0.03
Father is Employed			0.05*
Household Size		0.00	-0.00
Log of Household Grant Income		-0.02**	0.00
Resides in a Rural Area		-0.02	0.03
Number of Observations	20,936	14,891	4,160
R-squared	0.09	0.11	0.13

Fixed effects estimates are estimated to measure the impact of maternal depression on an individual's depression controlling for genetic, individual, parental and household characteristics. All wave and province dummies are included but not reported here. The base sample consists of Black/African depressed individuals between the ages of fifteen and fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

5.2.5 Investigating the CES-D Scale

In this section, the relationship between the binary of whether an individual is depressed or not and CES-D 10 scores in raw form using a log-log model is presented. In Table 9, the effect that maternal CES-D 8 scores and CES-D 10 scores for a number of cut-offs has on individual depression is presented. Across all sub-samples, maternal depression, severe

or not, is found to be the single largest determinant of individual depression conditional on all other controls. Whilst this is true, it is important to note that the explanatory power of the regression specifications is pretty low meaning there is a lot of unexplained variation still to be understood.

Table 10: Estimating Individual Depression and CES-D Scores

The Effect of CES-D 8 and CES-D 10 Score Cut Off on Individual Depression								
	Individual is Depressed (CES-D 8)		Individual is Severely Depressed (CES-D 10)				Log Transformed Score	
	CES-D 8 ≥ 8	CES-D 8 ≥ 8	CES-D 10 ≥ 12	CES-D 10 ≥ 12	CES-D 10 ≥ 16	CES-D 10 ≥ 16	Log CES-D 10	Log CES-D 10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mother Depressed (CES-D 8 > 8)	0.29***	0.28***						
Mother Depressed (CES-D 10 > 10)			0.18***		0.04***			
Mother is Severely Depressed (CES-D 10 ≥ 12)				0.21***				
Mother is Severely Depressed (CES-D 10 ≥ 16)						0.13***		
Log of Mother CES-D 10 Score							0.41***	0.44***
Age		-0.04*	-0.00	-0.00	-0.01	-0.01		-0.01
Years of Education		0.02**	0.01	0.01	-0.00	-0.00		0.02
Employed		0.03	0.01	0.01	0.01	0.01		-0.00
Mother Employed		-0.02	0.01	0.01	-0.00	-0.00		-0.01
Father Employed		0.04	0.02	0.02	-0.01	-0.01		0.03
Household Size		-0.00	-0.00	-0.00	-0.00	-0.00		-0.00
Log of Household Grant Income		-0.00	-0.02	-0.02	0.00	0.00		-0.01
Resides in a Rural Area		0.08	0.09	0.09	-0.10	-0.10		-0.09
Number of Observations	22,097	4,360	4,329	4,329	4,329	4,329	20,514	4,046
R-squared	0.11	0.12	0.08	0.08	0.02	0.03	0.14	0.17

Fixed effects estimates are estimated to measure the impact of maternal depression, CES-D 8 and CES-D 10 scores on an individual's depression, CES-D 8 and CES-D 10 scores controlling for other individual, parental and household characteristic. All wave and province dummies are inlcuded but are not resported here. The base sample consists of Black/African depressed individuals between the ages of fifteen and fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

In Table 10, severe depression was accounted for in Columns 3 to 6, while log-transformed CES-D 10 scores are presented in Columns 7 and 8, the effect that maternal depression has on individual depression is 10 percentage points higher (given a 1 percent increase in a score) than the effect that the binary outcome of depression has for for both CES-D scales as well as for all cut-offs. Hardly any other variables are found to be significant predictors of individual depression. Maternal depression is a highly robust and significant predictor of individual depression.

In the next section the veracity of maternal depression in the transmission effect is tested for a number of sub-samples.

5.3 Sub-sample Analysis of Maternal Depression

The estimates excluding paternal depression and residence in Column 5 of Table 7 are replicated in Table 10 for a number of sub-samples where the coefficient on maternal depression is reported.

Table 11 presents a sub-sample analysis on the conditional effect that maternal depression has on an individual, with the addition of all possible determinants of depression as well as all wave and province binaries. Column 1 explores a sample of the full sample of individuals aged 15 to 50, while Column 2 presents estimates for the same age cohort of Black/African individuals. While residence in some provinces has been found to be significant predictors of the transmission effect, Columns 3 to 5 investigate Black/African samples from the Western Cape, Gauteng and Mpumalanga. Finally, Columns 6 and 7 examine a Black/African sample of teenagers aged 15 to 19.

Across all of these samples, the coefficient of maternal depression is very large and highly significant. In addition, the size is fairly consistent across all samples ranging from a roughly 20 percentage point likelihood increase in transmission to a much higher likelihood of 34 percent for teens who identify as female. This is analogous and congruent to the literature on the determinants of maternal transmission of depression (Powdthavee & Vignoles 2008).

The majority of the maternal depression coefficients across all sub-samples are significant at the 1 percent level. For Black/African individuals in Column 2, the likelihood of depression is increased by a third for those with a depressed mother. These results are comparable to the full samples in Column 1, where education and employment have a mitigating effect on transmission. Although, sample sizes are relatively smaller, the maternal effect is still highly significant and the largest in Mpumalanga.

Table 11: Sub-sample Analysis of Maternal Depression

Estimation: Sub-sample Analysis of the Effect of Maternal Depresion on Individual Depression							
	Individual is Depressed (CES-D 10 ≥ 10)						
	All	Black/African	Provinces			Teens (15 - 19 Year Olds)	
			Western Cape	Gauteng	Mpumalanga	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mother is Depressed	0.27***	0.28***	0.23***	0.18***	0.28***	0.34***	0.22***
Age	0.02	0.01	-0.02	-0.00	0.04	0.06	-0.02
Years of Education	-0.07***	-0.06**	-0.01	-0.03	0.01	-0.13***	-0.03
Employed	-0.12	-0.44*	-0.04	-0.05	-0.01	-0.01	-0.21
Mother is Employed	0.08	0.07	0.05	0.02	0.08	0.08	0.06
Father is Employed	0.01	0.01	0.03	0.05	-0.20	0.03	0.01
Household Size	0.01	0.01	-0.02	-0.01	0.02	0.03	-0.01
Log Household Grant Income	-0.01	-0.03	0.01	0.03	0.07	-0.10**	0.10**
Rural	-0.04	-0.20	-0.04	-1.03*	0.61	0.16	-0.40
Number of Observations	1,850	1,509	673	516	191	992	858
R-squared	0.17	0.17	0.10	0.10	0.32	0.27	0.14

Fixed effects estimates are estimated to measure the impact of maternal depression on an individual's depression controlling for individual, parental and household characteristic. All other wave and province dummies are included but are not reported here. Individuals in columns (1) to (5) are aged fifteen to fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01

For adolescents and teens, the cash support grant captured in the overall household grant income is also found to have a mitigating effect on transmission. While this is confirmed in the literature (Eyal 2016, Eyal & Burns 2019), as discussed previously, this effect is quite large.[9] Strong and significant associations are found, with all associations significant at the one percent level in all samples despite small sample size for samples differentiated by province and teens.

In the next section, the effect of a shared family environment is explored to further determine the effect that maternal depression has on individual depression.

[9]This effect size is fairly large (a 1 percent increase in grant income, lowers depression by 1 percentage point), and similar surprising patterns are observed in household income as well (Eyal & Burns 2019). However, household grant income seems to suffer less from this problem of inexplicably large coefficient size and it is more reasonable to include it to lower the risk omitted variable bias than to exclude it given that it is not the main coefficient of interest.

5.4 The Shared Family Environment

The mental health of adolescents and their parents is simultaneously affected by an adverse household environment (Eyal & Burns 2019). In this section, the structure of the South African household is discussed and in addition, the effect that the rest of the family has on individual depression is further explored in Table 13. In the familial transmission effects presented in this table, depression among household members including only mothers and siblings is strongly associated with individual depression.

There have been significant changes in the domestic structure of the South African household since the dawn of colonialism in the nineteenth century. These changes (for example, land dispossession as well as the migrant labour and homeland system) continue to affect the outcomes of individuals in most parts in the rest of Africa today. In South Africa, children are more unlikely to reside with their biological parents (Anakpo & Kollamparambil 2021). This is mainly due to labour migration, another phenomenon exacerbated by the post-apartheid effect of labour migration and subsequent low marital rates of mothers. Consequently, many children are raised by their grandparents or other relatives, especially in rural areas (Rabe 2017, Knijn & Patel 2018).

According to national estimates, while a large percentage of households are classified as nuclear (couples, or one or more parent(s) with children), a third of households are classified broadly as extended households (a nuclear core combined with other family members such as parents or siblings) (Statistics South Africa 2021). The role played by families and extended families is important, particularly for grandparents who are able to share skills, teachings by passing on cultural traditions, including language, to their grandchildren (Mtshali 2015). Furthermore, approximately 15 percent of households had three generations present, while 5 percent were skip-generation households in which grandparents lived with grandchildren and no parents in the household. The highest percentage of skip-generation households were found in Eastern Cape (Statistics South Africa 2021). While triple-generation households were most common in Limpopo (19 percent), they were also found to be common in KwaZulu-Natal and Eastern Cape (both 18 percent).

Families and households are the most important socioeconomic institutions and play important roles in the care, as well as emotional and cognitive development of children (Madhavan et al. 2017). In South Africa, the more children there are in a household (more than 4 children), the greater the chances are that they are being looked after by extended family members (Department of Social Development 2015). Families and care arrangements are particularly important for vulnerable children. However, in South Africa, government support for parenting and families is limited and significant gaps exist in nutritional services and in providing care and learning opportunities for young children are equally scarce (Kamiya & Hertog 2020, Department of Social Development 2015, Statistics South Africa 2020, Statistics South Africa 2021).

Research suggests that non-nuclear structures are associated with similar negative effects for both boys and girls compared to children growing up in more nuclear households. However, the presence of other kin in the absence of one or both parents results in more favourable effects for boys. As such, the effects of other family members' presence may be moderated by parental presence (Madhavan et al. 2017). Although biological parents can play a central role in the development of children, the value of living with biological parents depends solely on the quality of care they can provide (Statistics South Africa 2021).

South Africa's entrenched circular labour migration has intensified the phenomenon of family structures and roles being in flux. These disruptions mean that biological parents, especially fathers, are not living with their children in the same household on a daily basis (Du Toit & Neves 2009). This cycle of migration can be attributed to a history of forced labour migration (Posel 2004) which continues to persist due to urban economic and educational opportunities, and cultural ties to rural homesteads in post-apartheid South Africa (Knijn & Patel 2018, Rabe 2017).

While poverty does not necessarily mean that a family will be vulnerable, it does make economic provision for family members stressful and burdensome. Many communities

continue to be sites of crime, violence, substance abuse, while gender-based violence occurs at extremely high levels (Meth 2017). Over time HIV and AIDS, and more recently the Covid-19 pandemic, have placed families under even more significant strain with loss of caregivers and economic providers (Hunt et al. 2021). Most families have been forced to function under incredibly difficult circumstances. While families in South Africa are characterised by apparent resilience, in troubled families in which conflict, neglect, or abuse occur on a regular basis, the oppression of certain family members, especially women and children is often common (Department of Social Development 2021).

Findings from a study using NIDS data show that intact married and cohabiting households have significant positive relationship with household reported well-being, and subjective well-being, respectively (Anakpo & Kollamparambil 2021). Furthermore, larger households and households headed by females and grandparents, have been found to have significantly lower levels household income and consumption. Larger household size is also found to negatively affect reported well-being, and while income is the traditional proxy of well-being, it does not always reflect mental well-being, especially in poorer communities of Black/African and Coloured individuals in South Africa. For instance, household income gain could be adversely affected by illness, crime, lack of economic freedom to consume undermining perceived well-being (Anakpo & Kollamparambil 2021).

Household fixed effects estimates, from a practical perspective, can eliminate time invariant and unobserved characteristics, particularly family factors reflecting a shared environment (Pawlby et al. 2009, Nwosu & Oyenubi 2021, Goodman & Gotlib 1999) in HH_i from Equation 1 and 2 above. Household-level fixed effects estimates specifically strip out the environmental effects to be left with only genetic effects. In addition, any changes in the coefficient on parental depression or interruption to the intergenerational transmission may reflect an improvement in the shared household environment (Eyal & Burns 2019). The mental health of individuals and the rest of their family, including their parents is thus simultaneously affected by an adverse household environment.

A robust connection between parental depression in the past and current individual depression would support the existence of a strong genetic component to intergenerational transmission, rather than environmental, as the household environment may change over time, while genetic factors, for the most part, will not (Eyal & Burns 2019). However, current, rather than past, parental mental health appears to be the most important for indicator for individual mental health (Eyal et al. 2017).

This implies that the shared environment may be a crucial determinant of the link between parental and individual or child mental health (Eyal & Burns 2019). The sample size of individuals does allow the calculation of household fixed effects estimates. However, such estimates would be identified from individuals living with two mothers and, given South Africa's three-generation households (e.g., a mother and a grandmother), this is possible (Levetan & Wild 2016, Eyal & Burns 2019).

Table 12: Estimating Individual Depression given Household Fixed Effects

The Effect of Transmission on Genetic and Environmental Factors				
	Transmission			
	Maternal	Paternal	Sibling	Grandmother
	(1)	(2)	(3)	(4)
Age	-0.02	-0.05	0.01	0.27
Education	0.05***	0.0254	0.03	-0.01
Employed	0.04	-0.18*	0.17	-0.12
Mother Employed	0.01		-0.05	0.19
Height	-0.00	-0.00	0.00	0.01*
Household Size	0.00	0.01	0.01	-0.06**
Log Household Government Income	0.02	0.06	-0.09	0.13
Household is in a Rural Area	-0.03	-0.15	0.36	-0.03
Number of Observations	5,063	1,542	872	465
R-squared	0.14	0.24	0.28	0.24

Fixed effects estimates are estimated to measure the impact of transmission of depression from resident housheold members on genetic, individual, parental and household characteristics. All wave and province dummies are included but not reported here. The base sample consists of individuals between the ages of fifteen and fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

In Table 13, if familial depression is presented as household level factors and other household-level factors are controlled for, the coefficient characterising the size of the maternal effects are significantly reduced while remaining significant at the one percent level. Conditional sample sizes remain large compared to the unconditional sample size in Column 1. Here, the genetic maternal depression effect is reduced by two thirds of the effect observed in Column 1 of Table 10. Further, with the addition of a depressed sibling in the household, the maternal transmission effect of individual depression is starkly reduced by up to 23 percentage points if the shared environment is controlled for.

The coefficient size of the effect of a depressed sibling is even larger, further reducing the

likelihood of transmission beyond by close to 75 percentage points. These results further confirm that the shared family environment (which includes the depression status of all family members in the household), is an important factor in determining the size and effect of transmission.

Table 13: Estimating Individual Depression given Household Fixed Effects

The Effect of Household Fixed Effects on Individual Depression				
	Individual is Depressed (CES-D 10 ≥ 10)			
	(1)	(2)	(3)	(4)
Mother is Depressed (CES-D 10 ≥ 10)	-0.20***	-0.19***	-0.19***	-0.23***
Has Depressed Sibling in Household				-0.73***
Height		-0.00	-0.00	0.00
Mother's Height		-0.00	-0.00	-0.00
Mortality in Last 24 months				
Years of Education				0.00
Log of Household Grant Income			-0.58	-0.42
Number of Observations	21,939	20,936	14,915	14,578
R-squared	0.01	0.01	0.01	0.08
Number of Households	13,919	13,376	8,960	8,803

Household fixed effects estimates are estimated to remove the shared environmental component in a household to measure the impact of a depressed mother or sibling while controlling for significant genetic, individual, parental and household characteristic. The base sample consists of Black/African depressed individuals between the ages of fifteen and fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

In the next section, following issues of omitted variable bias in determining causality of transmission mentioned in Section 5.2, an instrumental variable approach using a variable on whether a mother has ever had a still birth as a proxy for maternal depression will be explored.

5.5 Exploiting Exogeneity in Maternal Depression

In this section, exogeneity in maternal depression will be explored. Whether a mother has ever had a still-born child will act as an instrument for maternal depression. It is assumed that the death of a mother's child is found to solely have an effect on a mother herself. While the NIDS does not have a time dimension associated with when still-births happened in relation to the later births of other children, controlling for still-births which occurred before the individual themselves was born would have been more ideal in satisfying the above assumption. This section will discuss the literature on still-births and its connection to poor maternal mental health. In addition, Table 12 will present the manual approach to estimating the effect maternal transmission using maternal still-birth as a proxy for maternal depression. Table 13, will present this approach for a number of sub-samples including Black/African individuals, teenagers and depression status based on the CES-D 8 score. According to this approach, the effect that maternal depression has on transmission is much larger and significant across all samples compared to the estimates reported in previous estimations reported in this paper.

Much of the literature to date has grouped together all forms of pregnancy or perinatal loss including miscarriage, stillbirth and neonatal death. Although it is recognised that women can form attachments early on in pregnancy, there is evidence to suggest that the further along the pregnancy is, the greater the attachment the mother has to the baby, leading to a more severe grief reaction (Gold et al. 2018, Campbell-Jackson & Horsch 2014). Similarly, while the mechanisms are not quite clear, maternal prenatal mental health disorders appear to be associated with a moderate increase in the risk of stillbirth and infant mortality (Adane et al. 2021).

India, a developing country often likened to South Africa, has one of the highest number of stillbirths and the highest neonatal death rate in the world (Roberts et al. 2021). In the context of its society which promotes reproduction, women who experience perinatal loss often encounter significant social repercussions over and above grief such as experience stigma, guilt, blame, loss of status, discrimination, mistreatment, and abandonment or

divorce (Altijani et al. 2018). Perinatal loss, whether due to stillbirth or infant death, takes a heavy toll on women's mental health (Bhat & Byatt 2016, Gold et al. 2018, Shakespeare et al. 2019). Furthermore, even when pregnancy outcomes were favorable, adverse life circumstances put some women at higher risk for postnatal depression. Therefore, perinatal loss and postnatal depression are significant predictors maternal depression.

Given that the impact of maternal depression on individual depression can be interpreted as being endogenous to individual depression, estimating a simple specification of equation of interest that treats maternal depression as exogenous is important. Instrumental variables are used to estimate causal relationships when controlled experiments are not feasible or when a treatment is not successfully delivered to every observation. Intuitively, IVs are used when an explanatory variable of interest is correlated with the error term, in which case ordinary least squares give biased results (Lebenbaum et al. 2021, Clark et al. 2021).

Instrumental variable (IV) methods allow for consistent estimation when the explanatory variables (covariates) are correlated with the error terms in a regression model. Such correlation may occur when changes in the dependent variable change the value of at least one of the covariates (reverse causation), when there are omitted variables that affect both the dependent and independent variables, or when the covariates are subject to non-random measurement error.

In linear models, there are two main requirements for using IVs (Wooldridge 2015). First, the instrument must be correlated with the endogenous explanatory variable (maternal depression), conditionally on the other covariates. If this correlation is strong, then the instrument is said to have a strong first stage. A weak correlation may provide misleading inferences about parameter estimates and standard errors. The instrument cannot be correlated with the error term in the explanatory equation, conditionally on the other covariates. In other words, the instrument cannot suffer from the same problem as the original predicting variable. If this condition is met, then the instrument is said to satisfy

the exclusion restriction (Wooldridge 2015).

In 14, the instrumental variable approach is used to further investigate the effect of maternal depression on individual depression. The instrumental variable approach this paper will use is whether a mother has ever had a still birth to serve as an instrument on maternal depression. A valid instrument such as maternal stillbirth induces changes in the explanatory variable (maternal depression) but has no independent effect on the dependent variable - individual depression, in this case allowing the causal effect of the maternal depression on individual depression to be isolated. In this paper, we assume that stillbirth of a mother's child does not directly affect the depression of any living children.

A strong first stage should be that still birth predicts maternal depression, but those estimates (labelled first stage) appear in column 2 of Table 12, and while they are significant, the magnitude of the coefficient is small. In addition, the exclusion restriction is not met in Column 3. While Column 3 shows that there is indeed endogeneity present in the sample and that it is good that the instrument is significantly correlated with the endogenous regressor, future work needs to include the F stats or the Stock and Yogo tests to further justify these results.

Table 14: Instrumental Variable Approach to Estimate Individual Depression

	The Effect of Instrumenting Maternal Still-births for Maternal Depression on Individual Depression							
	Manual Procedure IV				Instrument: Maternal Still-birth			
	Individual Depressed	Mother Depressed	Individual Depressed		Individual Depressed			
	Structural Equation	First Stage	Endogeneity?	Second Stage	All	Black	Teens	CES-D 8 ≥ 8
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mother Depressed (CES-D 8 ≥ 8)								0.58***
Mother Depressed (CES-D 10 ≥ 10)	0.28***		0.73***		0.78***	0.86***	0.70***	
Residuals of First Stage Regression			-0.45***					
Predicted Mother Depression				0.70***				
Mother's Baby Cried but Later Died		-0.06***						
Number of Observations	21,939	30,410	25,957	25,957	25,957	21,912	24,011	24,185
R-squared		0.00	0.10					

Estimates including a variable on whether an individual's mother has ever had a still-birth as an instrument on maternal depression are estimated to measure the maternal intergenerational transmission effect of depression further. The base sample consists of individuals between the ages of fifteen and fifty in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

In Table 14 above, the coefficients in the IV models were of greater magnitude than those

in the OLS models. First stage F-statistics were less than 1 percent as seen in Column 1. Furthermore, results were consistent for both outcomes in all sensitivity analyses, including a sample of Black individuals in Column 5, depression based on the CES-D 8 in Column 8 as well as a sample for teens aged 15 to 19 years in Column 6.

Whilst we cannot make strong claims about causality, it is reassuring that the fixed effects model estimates accord with both the instrumental variable model, and other sub-samples of the fixed effects estimates. The impact of child death on maternal depression is significant. Particularly, for young mothers, however data including a view of how recent the child death was would be optimal but the NIDS does not report that information as the effects of still births are found to last for up to 3 years after the death (King-Hele et al. 2009).

Despite that the proposed instrument has a logical basis, the actual first stage coefficient observed is low (although highly significant), implying that although the instrument does cause a degree of exogeneity in maternal depression, in the expected direction, the magnitude of this change is not high. It is reassuring that the results agree with the other estimates, but it is likely that the temporal dimension (the unknown amount of time between the mother's still birth and the present) is weakening the effect.

The instrumental variable approach shows an up to 86 percentage point increase in the effect that maternal depression has on individual depression as seen in Columns 6 to 8 for a number of sub-samples in Table 13. These results confirm the fact that maternal depression is the single largest determinant of the transmission of depression - a result which is not surprising given the overwhelming evidence supporting this phenomenon outlined in the literature.

The next chapter further investigates the effect that this intergenerational transmission effect (from parents and other family member) has on vulnerable groups. This chapter also attempts to explore the determinants of resilience to transmission further.

6 Exploring Intergenerational Transmission of Depression

Following from the literature on the determinants of transmission in Section 2.3, resilience and vulnerability to transmission is examined for individuals aged 15 to 35. The sample age restriction is chosen such that only individuals who were most likely to have parents who were still alive or resident in their household during the NIDS Waves 1 to 5. Following this, a component analysis of the genetic and environmental determinants of transmission will be presented.

In Chapter 5 the intergenerational transmission of depression has been shown to be large and persistent, for both mothers and fathers. Transmission is higher in certain groups, as seen from the sub-sample analysis in Table 10. In this chapter, the nature of those who do become depressed when either parent is depressed is investigated. To clarify - the size and causality of the intergenerational effect is examined in detail in Chapter 5. In this chapter, the nature of that transmission is examined, and in particular the characteristics of those individuals who display depressive symptoms following parental depression observed in a previous wave. It is known that both genetic and environmental factors play a role in determining the likelihood of transmission, and the relative importance of these factors will differ depending on the local context.

In this paper, two definitions of resilience will be used. First, a 'past' definition including individuals who were not depressed in a previous wave, but had a mother who was depressed in the same previous wave, who then, became depressed - vulnerable individuals, and those who did not become depressed despite their mother's depression - resilient individuals. The 'current' definition includes individuals who were not depressed in a previous wave, but then also became depressed when their mother was depressed in the current wave - vulnerable individuals, and those who did not become depressed despite

their mother's depression - resilient individuals.

The next section presents differences in mean characteristics for individuals who are vulnerable to transmission, and individuals who are resilient to transmission given a mother's depression in the past or current wave.

6.1 Vulnerability to Transmission

Table 15 presents differences in mean characteristics for individuals who are resilient to maternal transmission and individuals who are vulnerable to maternal transmission. Put simply, these are differences between individuals who had depression transmitted from either parent and individuals who did not have transmission transmitted despite a parent's depression. There are significant differences between vulnerable and resilient groups across majority of individual characteristics. Similar to other results seen in this paper, household characteristics don't seem to differ significantly even with the addition of other characteristics such household income and whether or not a household is in the lowest income step. The results are similar for paternal transmission (see Appendix item A.2).

In Table 15, those who have had depression transmitted from their mother appear to differ significantly to those who have not had depression transmitted from their mother. On average, those who are depressed due to maternal transmission have individual and parental CES-D 10 and CES-D 8 scores which significantly differ to those who were not affected by the transmission. In this sample, average household grant income is significantly lower for those affected by maternal transmission at R1,261 compared to an average household grant income of R1,526 for those of which transmission did not occur.

While majority of the sample finds religion important, almost half of the sample is satisfied with life and a third of those who are vulnerable to transmission are found to be less satisfied with life. Half of the individuals who are resilient to transmission are happier now than they were 10 years ago than those who are vulnerable to transmis-

sion. It is important to note however that if the individual has been resilient and not become depressed, we would expect them to be happier than someone who has become depressed between the two periods; and be more satisfied with life. In other words, these are outcome variables correlated with the change in the depression status - at best, these co-efficient present correlations rather than anything predictive. Those who are vulnerable are slightly less educated. While only 8 percent of individuals have self-reported poor health in this sample, those who are vulnerable are 10 percent more likely to have poor health than individuals resilient to transmission. The results are similar for transmission of depression from a father (see item A.2).

Table 15: Mean Characteristics of Maternal Transmission

Mean Characteristics of Maternal Transmission				
	All	Trasmission from Mother Happened		Transmission from Mother Did Not Happen
CES-D 8 Score	5.46	9.53	***	3.28
CES-D 10 Score	8.14	12.9	***	5.61
Age	25.3	25.5		25.1
Female	0.53	0.56	***	0.51
Education	10.2	9.93	***	10.3
Mother CES-D 10 Score	13.0	13.4	***	12.8
Mother Age	52.9	53.4		52.7
Mother Education	7.61	7.42	*	7.71
Mother Employed	0.21	0.20		0.22
Father CES-D 10 Score	9.60	11.4	***	8.66
Father Age	55.9	54.9	**	56.3
Father Education	7.65	7.45		7.75
Father Employed	0.29	0.27		0.30
Housheold Size	6.19	6.8	***	5.87
Household Grant Income	1,465	1,361	**	1,526
Household is in a Rural Area	0.47	0.50		0.45
Number of Observations	6,518	2,201		4,317

This table presents mean values and significance tests of differences in individual and household characteristics between individuals who have had depression transmitted from their mother and those who have had no transmission occur, using a sample of individuals aged fifteen to fifty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in 2015 rands. Significant differences are starred. * implies p value < 0.10, ** implies p value <0.05, and *** implies p value < 0.01.

The next section estimates resilience and vulnerability of transmission for a number of determinants of transmission outlined in Section 2.3.

6.2 Determinants of Transmission

In Table 16, a model examining the effect that the environment and genetic characteristics (determinants of transmission) have on parental transmission is presented. This model is presented according to both definitions of transmission identified in the beginning of this chapter. This table aims to determine which factors have a mitigating effect on transmis-

sion. That is, the determinants of resilience to transmission.

Resilience is usually framed as resilience to a stressful environment and thus protection from the effects depression. As such, this also includes resilience to the big environmental factor - a mother of father's depression (Edward 2005). Unfortunately the NIDS does not have have data on the many traits known to be associated with resilience, but there are variables such as happiness now compared to 10 years ago, satisfaction with life, optimism about the future and the importance of religion.

While maternal depression is the single largest determinant of the intergenerational transmission of depression, in Table 17, the effect that other environmental factors have on the maternal transmission effect are estimated for a number of sub-samples. The only significant predictor of maternal transmission of depression was found to be education with significance at the 1 percent level.

Table 16: Estimating Parental Transmission

	Transmission from Parent's Depression in which Wave?			
	Mother		Father	
	Past	Current	Past	Current
	(1)	(2)	(3)	(4)
Black/African	0.01	0.01	-0.14	0.01
Age	0.00*	0.01***	0.01	0.01
Female	0.02	0.02	-0.10	0.09**
Education	-0.01	0.01*	-0.00	0.02**
Employed	-0.02	-0.04	-0.10	-0.02
Poor Health	0.04	0.02	0.01	0.02
Height	0.00	-0.00	-0.01*	-0.00
Satisified With Life	-0.10***	-0.11***	-0.07	-0.03
Finds Religion Important	-0.00	-0.00	-0.03	-0.11*
Is Happier Now Than 10 Years Ago	-0.13***	-0.12***	-0.07*	-0.08*
Mother Employed	-0.01	0.02		
Mother Age	-0.00	-0.00		
Father Employed			-0.02	0.11**
Father Age			0.00	-0.00
Household Size	-0.01	-0.00	0.00	0.00
Log Household Grant Income	-0.02	-0.01	-0.02	0.02
Log Household Income	-0.03	-0.01	-0.03	0.02
Optimistic: Higher Income Step in 2 Years	-0.03	-0.10***	-0.01	-0.10
Perceives HH is in Lowest Income Step	-0.01	-0.05	0.04	-0.07
HH is in Lowest Income Step	0.02	0.05	-0.1	0.18**
HH Resides in Rural Area	-0.05*	0.03	-0.10*	-0.04
Wave 2	-0.03	0.01	-0.02	0.04
Wave 3	-0.02	0.01	-0.02	0.07
Wave 4	-0.90*	-0.08*	0.10	-0.05
Wave 5	-0.01	-0.07**	0.04	-0.13**
Eastern Cape	-0.07	-0.06	-0.09	0.01
Northern Cape	-0.15**	-0.21***	-0.23**	-0.23**
Free State	-0.08	-0.14*	0.10	0.10
Kwa-Zulu Natal	-0.05	-0.16**	0.19	0.19
North West	-0.15**	-0.18**	0.11	0.11
Gauteng	-0.05	-0.12	0.09	0.09
Mpumalanga	-0.17**	-0.26***	-0.05	-0.16
Limpopo	-0.11	-0.21**	0.02	-0.23**
Number of Observations	1,441	716	405	764
R-squared	0.08	0.09	0.15	0.11

Ordinary least square estimates are estimated to measure the impact of parental transmission of depression on genetic, individual, parental and household characteristics. All wave and province dummies are included. The base sample consists of individuals between the ages of fifteen and thirty-five in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

Goodman (2020) found that the typically protective effects of offspring's higher IQ were reversed among those whose maternal depression was severe and chronic. They found that the children's greater IQ enabled them to have a greater understanding of the situation and, thus, more distress (Horowitz & Garber 2003). Perhaps in a similar way, for depressed Black/African individuals who are more educated than their peers, conceptualising the severity and effects of (parental) depression may come more naturally and have more consequences for the likelihood of transmission.

To further investigate the intergenerational transmission effect, Table 19 estimates this effect across a number of sub-samples. In Column 1, maternal transmission is estimated for a number of genetic and environmental factors for individuals aged 15 to 35. Across all sub-samples of maternal transmission, with the exception of life satisfaction and happiness, not very many characteristics are found to be significant. This means that very few characteristics are found to have an effect on resilience or vulnerability to transmission.

In Table 17, Column 1 presents a sample of teenagers aged 15 to 19. Column 2 to 6 includes a sample of individuals aged 15 to 35. Column 2 presents a sample of those who identify as female, while Column 3 includes individuals who perceive that they are in the lowest income step. Column 4 and 5 respectively include those who are happier and those who find religion import. Column 6 includes those who have optimism regarding better income in the future. In all these samples, while age increases the probability of vulnerability to transmission, optimism about better income in the future is found to increase resilience to transmission significantly. Other than these measures of well-being, no other characteristics or determinants of transmission are found to have an effect on transmission.

Table 17: Sub-sample Analysis of Maternal Transmission

	Transmission					
	Teens	Female	Perceives HH Lowest Inc Step	Happier Than 10 Yrs Ago	Religion Important	Optimism: Higher Inc in 2 Yrs
	(1)	(2)	(3)	(4)	(5)	(6)
Black/African	0.03	0.06	0.01	0.16**	0.00	0.04
Age	0.04**	0.01***	0.01	0.01***	0.01***	0.01***
Female	0.06		0.04	0.01	0.01	0.02
Satisfied With Life	-0.10**	-0.13***	-0.09**	-0.09***	-0.11***	-0.08***
Religion is Important	-0.01	-0.06	0.07	0.03		-0.01
Is Happier Now Than 10 Years Ago	-0.12***	-0.11***	-0.07*		-0.11***	-0.11***
Education	0.02	0.01	0.00	0.02**	0.01**	0.01
Employed	0.14	-0.04	-0.06	-0.04	-0.05*	-0.04
Poor Health	0.06	-0.02	0.06	0.02	0.02	0.03
Height	-0.00	-0.00	-0.01	-0.00	-0.00	-0.00
Mother Employed	0.03	0.05	0.04	0.01	0.00	0.04
Mother Age	0.00	-0.00	0.00	-0.00**	-0.00**	-0.00*
Household Size	0.00	-0.00	-0.01	-0.00	-0.00	-0.00
Log Household Income	0.02	0.00	0.02	0.00	-0.00	-0.01
Log Household Grant Income	-0.02	-0.01	0.03	-0.01	-0.005	-0.004
Child Support Grant Recipient	0.01					
Optimistic: Higher Income Step in 2 Years	-0.10**	-0.09***	-0.13***	-0.06*	-0.10***	
Perceives HH is in Lowest Income Step	0.04	-0.04		0.01	-0.04	-0.06
HH is in Lowest Income Step	0.03	0.06	0.07*	0.06	0.06	0.05
HH Resides in a Rural Area	-0.01	0.01	0.01	0.02	0.03	0.02
Wave 2	-0.05	-0.06	-0.00	-0.02	-0.01	0.05
Wave 3	-0.03	0.01	-0.05	-0.02	0.01	-0.02
Wave 4	-0.04	-0.13***	-0.16**	-0.10**	-0.08*	-0.08*
Wave 5	-0.04	-0.10**	-0.10	-0.06	-0.09**	-0.06
Eastern Cape	-0.00	-0.03	-0.11	-0.08	-0.03	-0.06
Northern Cape	-0.34***	-0.14	-0.29**	-0.25***	-0.20***	-0.23***
Free State	-0.21	-0.12	-0.19	-0.28***	-0.10	-0.19**
Kwa-Zulu Natal	-0.20*	-0.15*	-0.24**	-0.25***	-0.13*	-0.20***
North West	-0.15	-0.18*	-0.29**	-0.33***	-0.16**	-0.19*
Gauteng	-0.193	-0.163*	-0.141	-0.219**	-0.07	-0.11
Mpumalanga	-0.17	-0.31***	-0.31**	-0.37***	-0.23**	-0.29***
Limpopo	-0.27**	-0.20*	-0.30**	-0.30***	-0.18**	-0.22**
Number of Observations	668	1,405	786	1,147	2,110	1,701
R-squared	0.12	0.10	0.10	0.07	0.08	0.07

Ordinary least square estimates are estimated to measure the impact of transmission of depression on genetic, individual, parental and household characteristics for different sub-samples including teens aged fifteen to nineteen in column (1). All wave and province dummies are included. The rest of the samples consist of individuals between the ages of fifteen and thirty-five in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

Furthermore, some researchers have found that it is only in the presence of multiple potential protective environmental factors that offspring of depressed parents manage to avoid being depressed themselves (Collishaw et al. 2016). However, given that the family represents a shared environment it is expect that the mental health of household members is closely related, (Goodman 2020, Eyal & Burns 2019). Various studies based on both adult and adolescent patients have also shown that major depression is a family disorder (Steinhausen et al. 2009, Klein et al. 2001, Schreier et al. 2006).

Table 18 presents the lateral transmission effect to investigate which genetic and environmental characteristics have an effect on vulnerability and resilience to transmission of depression from other members of the household.

Column 1 and Column 2 respectively present maternal and paternal transmission, while Columns 3 and 4 respectively present transmission of depression from a sibling or a maternal grandmother. Column 5 includes a sample of individuals who (excluding themselves) have at least one person in their household who is depressed. While sample sizes are rather small due to the fact that depression is only recorded for resident household members, across most of the samples, satisfaction in life and happiness now compared to 10 years ago is found to reduce transmission. These determinants are found to increase resilience to transmission from the family. This is analogous to literature outline in Section 2.3.

In terms of the effect on paternal transmission, at the 10 percent level of significance, whether an individual is employed decreases the likelihood of transmission by 18 percentage points. While a small sample size is observed in Column 4, the likelihood of transmission of depression from a maternal grandmother given household size is found to decrease by 6 percentage points. The next section includes a component analysis of these determinants.

Table 18: Lateral Transmission (Other Household Members)

	Transmission				
	Maternal	Paternal	Sibling	Grandmother	Someone in HH
	(1)	(2)	(3)	(4)	(5)
Black/African	0.01	0.01	0.02	0.12	0.08
Age	0.01***	0.01	0.01**	-0.01	0.01***
Female	0.02	0.09**	0.09**	-0.01	0.11***
Satisfied With Life	-0.11***	-0.03	-0.10***	-0.14*	-0.05
Religion is Important	-0.00	-0.11*	-0.04	0.12	-0.12**
Is Happier Now Than 10 Years Ago	-0.12***	-0.08*	-0.13***	-0.03	-0.15***
Education	0.01*	0.02**	-0.00	-0.03	0.01
Employed	-0.04	-0.02	-0.05	-0.02	-0.02
Poor Health	0.02	0.02	0.01	0.30**	0.08
Height	-0.00	-0.00	0.00	0.00	0.00
Mother Employed	0.02		0.03		0.03
Mother Age	-0.00		-0.00		-0.00
Father Employed		0.11**			0.04
Father Age		-0.00			0.00
Household Size	-0.00	0.00	-0.01	-0.01	-0.01**
Log Household Income	-0.01	0.02	0.01	-0.04	-0.00
Log Household Grant Income	-0.01	0.02	-0.00	-0.08	-0.05**
Optimistic: Higher Income Step in 2 Years	-0.10***	-0.08	-0.10***	0.01	-0.08**
Perceives HH is in Lowest Income Step	-0.05	-0.07	-0.04	-0.03	-0.06
HH is in Lowest Income Step	0.05	0.18**	0.07	0.01	0.10**
HH Resides in a Rural Area	0.03	-0.04	0.09**	-0.13	-0.02
Wave 2	0.01	0.04	0.04	0.07	0.06
Wave 3	0.01	0.07	0.08	0.12	0.05
Wave 4	-0.08*	-0.05	-0.04	0.14	0.05
Wave 5	-0.07**	-0.13**	-0.06	0.13	0.03
Eastern Cape	-0.06	0.01	0.05	-0.11	-0.04
Northern Cape	-0.21***	-0.21**	-0.18*	-0.26	-0.15**
Free State	-0.14*	-0.07	-0.13	0.04	-0.16
Kwa-Zulu Natal	-0.16**	-0.02	-0.07	0.07	-0.10
North West	-0.18**	0.09	-0.13	-0.10	-0.11
Gauteng	-0.12	-0.06	-0.04	-0.08	-0.11
Mpumalanga	-0.26***	-0.16	-0.13	-0.28	-0.16
Limpopo	-0.21**	-0.23**	-0.22**	-0.19	-0.20**
Number of Observations	2,378	764	1,242	222	1,179
R-squared	0.09	0.11	0.10	0.18	0.11

Ordinary least square estimates are estimated to measure the impact of transmission of depression from resident housheold members on genetic, individual, parental and household characteristics. All wave and province dummies are included. The base sample consists of individuals between the ages of fifteen and thirty-five in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

6.3 Component Analysis of Transmission

The determinants of transmission have not been consistent across specifications, although certain results do accord with a theory of resilience protecting individuals from being affected by their proximity to parents with poor mental health. However, very many of the determinants are not significant, possibly due to their inter-relatedness. With the release of a lasso[10] module in Stata 16, it was possible to perform a brief robustness check on the best predictors of the transmission models. A lasso model is used to investigate which factors previously included in the regression analysis are most suited for inclusion into these models, and which should have the strongest effects (Tibshirani 1996).

In the South African context, where many different measures of socio-economic status are potential predictors of poor mental health, the lasso technique is helpful to discern the most useful of these. It is important to note that theoretical assumptions regarding the determinants of poor mental health over-ride any conflicting results from the lasso model, as to omit these would result in omitted variable bias. Although sample size in the NIDS is never smaller than the number of potential determinants, the process is still of interest in finding an efficient model.

In Table 19, the results of ordinary least squares estimates, including all possible predictors of transmission are presented. The effect that the inclusion of the other parent's depression has is large and highly significant. This simply means that parental depression is the single largest determinant of transmission. Hardly any genetic or other environmental characteristics have been found to significant determinants of transmission. This means that the environment does not seem to have as large of an effect on resilience or vulnerability to transmission, as was previously thought in previous literature. It is only parental depression itself which has the largest effect on whether an individual is resilient or vulnerable to transmission. Table 19 presents the same estimates but for transmission from a father. While sample sizes are smaller in Table 19 compared to Table 18 due to

[10]Least Absolute Shrinkage and Selection Operator (lasso) estimates model coefficients estimates can be used to select which covariates should be included in a model. The lasso is used for outcome prediction and for inference about causal parameters (Wang et al. 2007, Bühlmann 2010)

low paternal residence in the households, the results are comparable.

Ordinary least squares estimates, including all possible predictors of transmission are presented in Column 1 of Table 18. In Column 2, the same estimation is presented using only those characteristics or determinants selected to have non-zero/non-shrinking coefficients after the lasso process (Tibshirani 1996). Most of these chosen determinants can be seen to be significant and have fairly substantial sizes compared to many of the coefficients in Column 1. In Column 3, Column 1 is replicated, with the addition of paternal characteristics (paternal depression, paternal age and whether a respondent's father is employed), and the same process repeated to obtain only the variables deemed to have non-zero coefficients by the lasso model. It can be seen that the subset of covariates in Column 4 is much smaller and includes paternal depression which is significant at the 1 percent level.

Thus, it is inferred that the mental health status of the other parent is also very important in determining the resilience of an individual to their other parent's mental health.

In Table 19, employment is found to increase resilience to maternal transmission. In Column 2 and Column 4, being employed increases resilience at 1 percent level of the significance. However, this is not the case for the lasso covariates of paternal transmission in Table 19. Optimism about the future and happiness now compared to the past are found to be significant determinants of transmission at the one percent level. These variables decrease the likelihood of transmission of depression (increase resilience) by up to 13 percentage points.

In both Table 19 and 20, the other parent's depression is the largest and most important determinant of transmission as seen in Column 4. If the other parent is depressed, vulnerability to transmission is increased by close to a third.

Table 19: Lasso Regression for Maternal Transmission

	Maternal Transmission			
	Mother's Characteristics Only	Lasso Covariates	Including Father's Characteristics	Lasso Covariates
	(1)	(2)	(3)	(4)
Father is Depressed			0.23***	0.27***
Black/African	0.01		-0.03	
Age	0.01***	0.01***	0.01*	
Female	0.02	0.06***	0.06	0.07**
Satisfied With Life	0.02		0.05	
Religion is Important	-0.00		-0.00	
Is Happier Now Than 10 Years Ago	-0.11***	-0.10***	-0.11**	-0.11***
Education	-0.00		-0.10*	
Employed	-0.12***	-0.14***	-0.13***	-0.13***
Poor Health	0.01**	-0.00	0.01	
Height	-0.04		-0.04	
Mother Employed	0.02		0.02	0.08**
Mother Age	-0.00*		-0.01	
Father Employed			0.0479	
Father Age			-0.00	
Household Size	-0.00		0.00	
Log Household Income	-0.01		0.01	
Log Household Grant Income	-0.01		-0.01	
Optimistic: Higher Income Step in 2 Years	-0.10***	-0.09***	-0.09**	
Perceives HH is in Lowest Income Step	-0.05*		0.01	
HH is in Lowest Income Step	0.05	0.01	0.05	
HH Resides in a Rural Area	0.03		0.00	
Wave 2	0.01		0.05	
Wave 3	0.01		0.06	
Wave 4	-0.08**		0.01	
Wave 5	-0.07**	-0.06***	-0.03	
Eastern Cape	-0.06	0.08**	0.03	
Northern Cape	-0.21***	-0.08*	-0.11	
Free State	-0.14**		-0.05	
Kwa-Zulu Natal	-0.16***		-0.10	
North West	-0.18***		-0.10	
Gauteng	-0.12**		-0.06	
Mpumalanga	-0.26***	-0.10**	-0.16	
Limpopo	-0.21***		-0.25*	
Wave 3 (No Base Wave)		0.03		
Western Cape (No Base Province)		0.10***		
Number of Observations	2,378	3,463	716	1,114
R-squared	0.09	0.07	0.18	0.14

Ordinary least square estimates are estimated to measure the impact of transmission of maternal transmission of depression from a current wave on genetic, individual, parental and household characteristics. All wave and province dummies are included. In columns (2) and (4), the least absolute shrinkage and selection operator (lasso) covariates based on column (1) and (2) are shown. The base sample consists of individuals between the ages of fifteen and thirty-five in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

Table 20: Lasso Regression for Paternal Transmission

	Paternal Transmission			
	Father's Characteristics Only	Lasso Covariates	Including Mother's Characteristics	Lasso Covariates
	(1)	(2)	(3)	(4)
Mother is Depressed			0.26***	0.26***
Black/African	0.01		0.00	
Age	0.01	0.00	0.01	0.00
Female	0.10**	0.10***	0.01	0.04
Satisfied With Life	-0.03		-0.08	-0.10**
Religion is Important	-0.11*		-0.11	
Is Happier Now Than 10 Years Ago	-0.08*	-0.10***	-0.03	-0.06
Education	0.02**	0.00	0.03***	0.01
Employed	-0.02		-0.01	
Poor Health	0.02		-0.00	
Height	-0.00		-0.00	
Mother Employed			0.08	
Mother Age			0.00	
Father Employed	0.11**	0.08**	0.11*	0.10**
Father Age	-0.00		-0.00	
Household Size	0.00	0.01**	0.01	
Log Household Income	0.02		-0.01	
Log Household Grant Income	0.02		0.01	
Optimistic: Higher Income Step in 2 Years	-0.08	-0.10***	-0.10*	-0.13***
Perceives HH is in Lowest Income Step	-0.07		-0.08	
HH is in Lowest Income Step	0.18**	0.10**	0.17**	0.09*
HH Resides in a Rural Area	-0.04		-0.09	-0.03
Wave 2	0.04		0.06	
Wave 3	0.07		0.12	
Wave 4	-0.05		0.00	
Wave 5	-0.13**	-0.12***	-0.06	-0.09**
Eastern Cape	0.01		0.03	
Northern Cape	-0.21**		-0.15	
Free State	-0.07		-0.02	
Kwa-Zulu Natal	-0.02		0.00	
North West	0.09	0.06	0.15	0.10
Gauteng	-0.06		-0.10	
Mpumalanga	-0.16		-0.07	
Limpopo	-0.23**	-0.16***	-0.14	-0.14*
Wave 3 (No Base Wave)		0.05		0.08
Northern Cape (No Base Wave)		-0.17***		-0.18***
Number of Observations	764	1,162	590	873
R-squared	0.11	0.08	0.17	0.16

Ordinary least square estimates are estimated to measure the impact of transmission of paternal transmission of depression from a current wave on genetic, individual, parental and household characteristics. All wave and province dummies are included. In columns (2) and (4), the least absolute shrinkage and selection operator (lasso) covariates based on column (1) and (2) are shown. The base sample consists of individuals between the ages of fifteen and thirty-five in each wave. * implies p value < 0.10, ** implies p value < 0.05, and ***implies p value < 0.01.

Table 20 shows similar results for paternal transmission, with a shrinking of the covariate list (after lasso) when maternal characteristics are included. When a mother is depressed, the likelihood of having depression transmitted from a father is increased by close to a third as well. These coefficients on parental depression are similar to those seen throughout this paper. This means that parental depression is indeed an important predictor of poor mental health and the transmission effect.

Further investigation is beyond the scope of this thesis, although it is pleasing to note that the results from the lasso model are fairly similar to those seen in the previous sections of Chapter 6 and that they help explain some of the anomalies seen previously in Table 15.

7 Conclusion

This thesis estimated causality in the intergenerational transmission effect of depression from parent to individual while presenting potentially confounding factors and robustness checks of these results. Parental depression is the the single largest determinant of individual depression. That is, individuals with depressed parents are more likely to suffer from depression themselves.

This paper has also attempted to explore vulnerability and resilience to this transmission effect and finds that a mother's depression is the largest and most important determinant of transmission of depression from a father. The opposite is also true - a father's depression is the single and largest determinant of transmission of depression from a mother.

Upon further investigation of the exact components or determinants of resilience or vulnerability to transmission using the Least Absolute Shrinkage and Selection Operator (lasso) model, this paper finds that hardly any other genetic or other environmental characteristics have been found to significant determinants of transmission. It is only parental depression alone which has the largest effect on whether an individual is resilient or vulnerable to transmission from another parent. This paper finds that the environment does not seem to have as large of an effect on resilience or vulnerability to transmission of

depression as was previously thought in the literature - only parental depression seems to have an effect on the transmission of depression.

While it is beyond the scope of this thesis, future work on this topic could include a genetic relatedness index as an independent variable where for instance, parents each pass 0.5 DNA onto their children. Similarly, there is genetic similarity between siblings, grandparents aunts and other family members that can be translated into an index to attempt to strip out the genetic component specifically.

A limitation of this thesis is that it fails to determine whether there is something to be gained by pooling data across the 5 waves given that some individuals will appear in multiple waves, and have multiple measures of mental health responses. It does not fully explore what pooled data implies for the mean and standard deviations of the CESD-10 scale. While the thesis explores the distribution of the item responses on scale in Chapter 3, it treats these multiple observations for a given individual as though they were independent which is problematic if there are no particular sample size concerns. Future work ought to determine how mean estimates are affected if depression is episodic as opposed to sustained, or vice-versa.

This the thesis alludes to the effect that parental residence has on an individuals depression, however, it fails to truly wanted to explore the impact of having a resident parent, versus a non-resident fully. Future work could provide a more nuanced approach that exploits the panel structure of the data to consider the mental health status of individuals who have resident versus non-resident live parents and resident parents versus parents who have died (absent but no longer living). This would provide an additional avenue to understand the genetic component (which persists even if one's parent has died) as opposed to a simple residency effect.

There is a need to reframe the global mental health agenda envisioned in the Sustainable Development Goals (SDGs). This is supported by WHO's Comprehensive Mental Health

Action Plan which protects the rights of people with psycho-social disabilities (World Health Organization et al. 2008). Poor mental health exists along the spectrum of mild, time-specific stress to chronic, more severely debilitating mental illness. The binary approach to diagnosing mental disorders, although useful, does not definitively or accurately reflect the complexity of mental health. Mental health outcomes for individuals reflect the unique connection of social and environmental influences (especially in earlier stages of development) which also interact with genetic and biological pathways in the brain (Patel et al. 2018).

Integrating community based programs which aim to address and alleviate poverty while providing mental health services is very likely to improve resilience in vulnerable groups in South Africa (Stallard et al. 2005). When treatment is too expensive or inaccessible, it may also be more effective to employ other protective interventions to promote resilience to poor mental health such as building community based relationships and encouraging spirituality in order to find strength in struggle (Haglund et al. 2007, Kaplan & Sadock 1989). A number of successful, low-cost, community-led interventions such as problem-solving therapy to treat poor mental health have been implemented in sub-Saharan African countries such as Zimbabwe (Keynejad et al. 2020, Bitew et al. 2021), and the same could be highly beneficial in a similar country like South Africa.

A Appendices

A.1 Mean Characteristics by Parental Depression for African and Coloured Individuals

Table 21 presents sample means for Coloured individuals who are depressed and individuals who are not depressed between the ages of 15 and 50 in Waves 1 to 5, with significant differences marked with stars.

Table 21: Mean Characteristics by Parental Depression for Coloured Individuals

	All	Mother is Depressed		Mother is Not Depressed	All	Father is Depressed		Father is Not Depressed
CES-D 8 Score	3.63	6.11	***	2.64	3.58	6.57	***	2.67
Depressed (CES-D 8 $\geq$ 8)	0.17	0.38	***	0.09	0.18	0.48	***	0.09
CES-D 10 Score	5.83	8.70	***	4.68	5.73	9.36	***	4.63
Depressed (CES-D 10 $\geq$ 10)	0.20	0.42	***	0.11	0.21	0.52	***	0.11
Depressed (CES-D 10 $\geq$ 12)	0.13	0.31	***	0.05	0.11	0.29	***	0.11
Depressed (CES-D 10 $\geq$ 16)	0.03	0.07	***	0.11	0.02	0.03		0.01
Age	25.4	26.1		25.1	24.4	24.6		24.4
Female	0.49	0.51		0.49	0.51	0.43	***	0.53
Education	10.1	10.1		10.2	10.1	10.2		10.1
Poor Health	0.06	0.10	**	0.04	0.04	0.05		0.04
Mother CES-D 10 Score	6.91	13.5	***	4.34	6.48	11.2	***	5.17
Mother is Depressed (CES-D 10 $\geq$ 10)	0.28	1.00	***	0.00	0.24	0.65	***	0.13
Mother is in Poor Health	0.22	0.30	**	0.18	0.21	0.23		0.21
Mother Ever Had Still-born	0.22	0.30	**	0.19	0.19	0.20		0.19
Mother's Age	51.2	52.3		50.7	49.5	49.3		49.5
Mother Education	8.57	8.35		8.65	8.82	8.95		8.78
Mother is Employed	0.30	0.25	**	0.32	0.33	0.36		0.33
Father CES-D 10 Score	6.06	10.2	***	4.72	6.04	12.9	***	4.06
Father is Depressed (CES-D 10 $\geq$ 10)	0.22	0.58	***	0.10	0.22	1.00		0.00
Father Age	52.3	52.5		52.2	53.4	53.0		53.5
Father Education	9.03	8.73	*	9.13	9.03	9.06		9.02
Father is Employed	0.56	0.55		0.56	0.53	0.57		0.52
Household Size	5.48	5.24		5.57	5.34	4.84		5.49
Household Government Income	1,524	1,570		1,501	1,530	1,355		1,582
Household is in a Rural Area	0.08	0.08		0.07	0.10	0.11		0.10
Number of Observations	4,398	965		3,433	2,167	368		1,799

This table presents mean values and significance tests of differences in individual and household characteristics between individuals who have a depressed parents and individuals who do not have depressed parents, using a sample of Coloured individuals aged fifteen to sixty in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in 2015 rands. Significant differences are starred. * implies p value < 0.10, ** implies p value <0.05, and *** implies p value < 0.01.

A.2 Mean Characteristics of Paternal Transmission

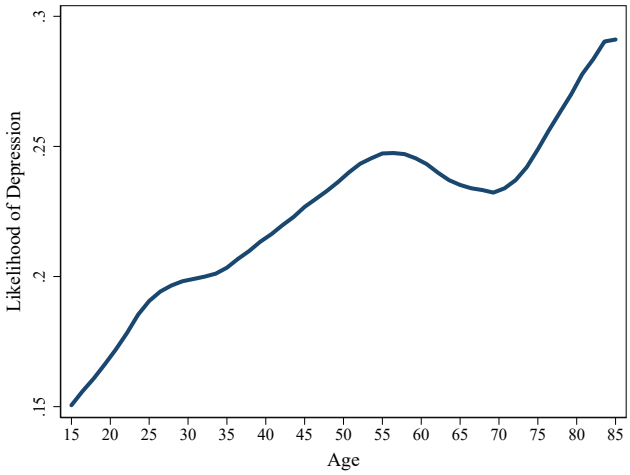
Table 22: Mean Characteristics of Paternal Transmission

	Past Wave				Current Wave			
	All	Trasmission from Father		No Transmission from Father	All	Trasmission from Father		No Transmission from Father
CES-D 8 Score	4.47	9.86	***	2.93	5.92	9.65	***	3.26
CES-D 10 Score	7.02	13.3	***	5.23	8.75	12.9	***	5.76
Father is Depressed (CES-D $\geq$ 10)	0.34	0.65	***	0.26	0.60	0.75	***	0.48
Satisified With Life	0.45	0.34	**	0.48	0.44	0.39		0.47
Finds Religion Important	0.85	0.81		0.87	0.88	0.89		0.87
Is Happier Now Than 10 Years Ago	0.55	0.45	**	0.58	0.51	0.38	***	0.60
Age	27.5	29.2	*	27.1	25.4	25.2		25.5
Female	0.48	0.49		0.48	0.48	0.57	***	0.42
Education	10.7	10.5		10.7	10.7	10.6		10.8
Poor Health	0.07	0.11		0.06	0.05	0.05		0.05
Mother CES-D 10 Score	8.08	11.6	***	7.21	10.2	11.9	***	8.96
Mother Age	53.3	53.2		53.3	52.8	52.4		53.2
Mother Education	8.01	7.83		8.05	7.73	7.41		7.95
Mother Employed	0.24	0.27		0.24	0.22	0.20		0.25
Father CES-D 10 Score	7.28	9.66	***	6.73	12.5	12.9	***	12.3
Father Age	59.3	59.2		59.4	58.7	58.2		59.0
Father Education	7.34	6.83		7.47	7.38	7.19		7.52
Father Employed	0.25	0.28		0.24	0.25	0.29		0.23
Housheold Size	6.00	5.87		6.04	6.11	6.70	***	5.69
Household Grant Income	1,460	1,363		1,486	1,509	1,579		1,450
Household Income	7,378	7,827		7,250	7,045	7,668		6,599
Optimistic: Higher Income Step in 2 Years	0.71	0.67		0.72	0.72	0.65	**	0.76
Perceives HH is in Lowest Income Step	0.25	0.35	**	0.22	0.29	0.29		0.29
HH is in Lowest Income Step	0.14	0.21	**	0.12	0.14	0.15		0.13
Household is in a Rural Area	0.46	0.4		0.48	0.45	0.46		0.44
Number of Observations	856	198		658	1,167	511		656

This table presents mean values and significance tests of differences in individual and household characteristics between individuals who have had depression transmitted from their father in a past or current wave and those who have had no transmission, using a sample of individuals aged fifteen to thirty-five in Waves 1 to 5 of the National Income Dynamics Survey, weighted using individual sample weights. All income variables are measured in 2015 rands. Significant differences are starred. * implies p value < 0.10, ** implies p value <0.05, and *** implies p value < 0.01.

A.3 Depression (CES-D 8) by Age

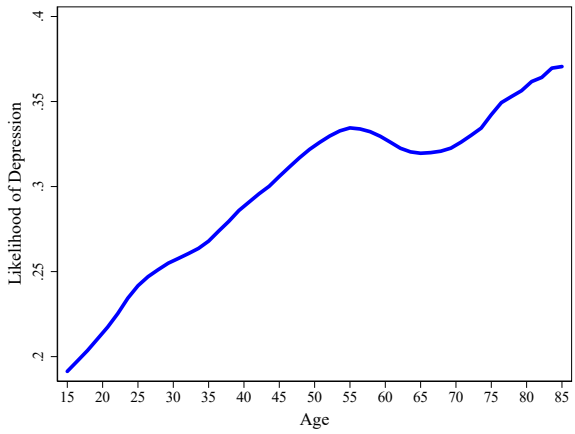
Figure 6: Depression (CES-D 8) by Age



A.4 Likelihood of Depression over Age for Black/African and Coloured Individuals

Figure 7: The Likelihood of Depression over Age

7(a). Black/African Individuals



7(b). Coloured Individuals

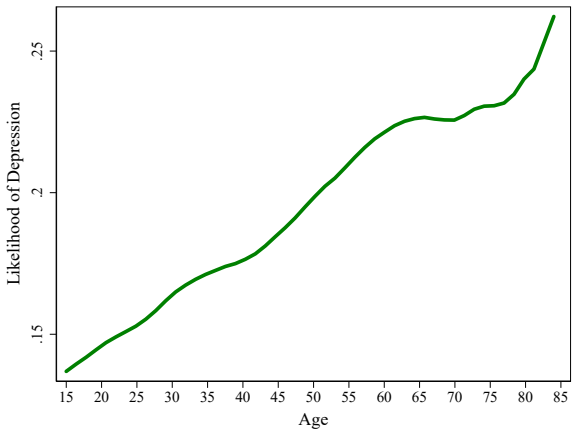
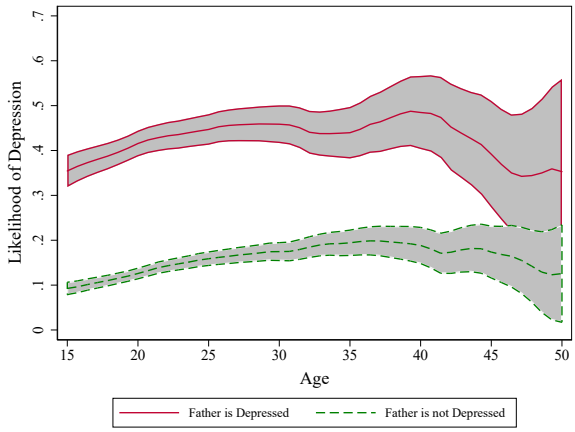


Figure 7 shows the proportion of Black/African and Coloured individuals who are depressed over age. Source: NIDS Waves 1 to 5.

Figure 8: Intergenerational Transmission: Paternal

8(a). CES-D 10



8(b). CES-D 8

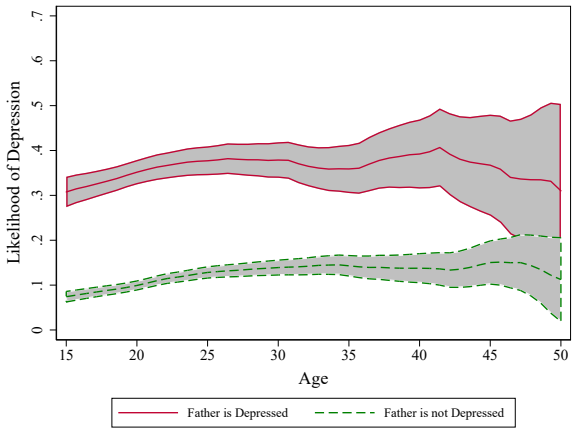
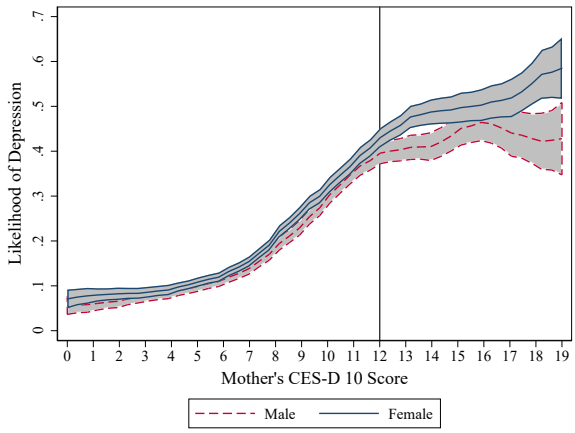


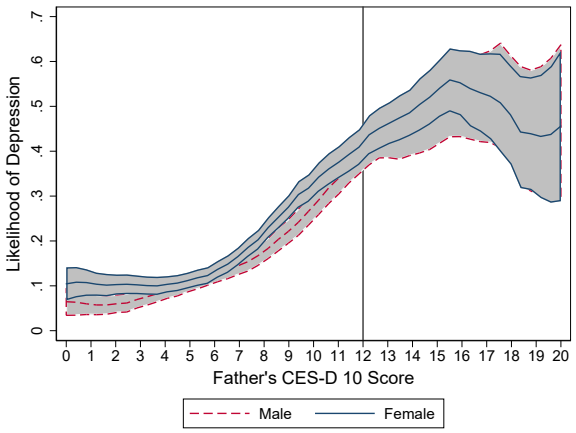
Figure 8 shows the likelihood of depression for individuals who have depressed fathers. 95% confidence intervals are shown. Source: NIDS Waves 1 to 5.

Figure 9: Intergenerational Transmission: Either Parent (CES-D 10 $\geq$ 12)

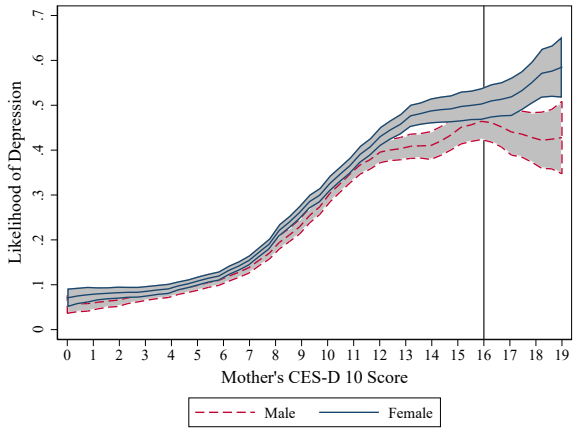
9(a). Maternal CES-D 10 $\geq$ 12



9(b). Paternal CES-D 10 $\geq$ 12



9(c). Maternal CES-D 10 $\geq$ 16



9(d). Paternal CES-D 10 $\geq$ 16

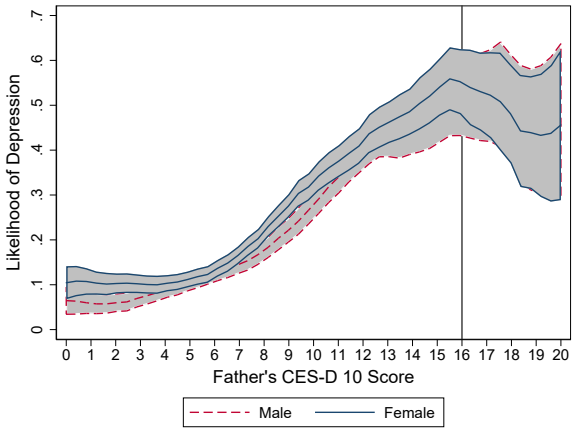


Figure 9 shows the likelihood of depression for individuals who have depressed parents with a CES-D 10 $\geq$ 12. 95% confidence intervals are shown. Source: NIDS Waves 1 to 5.

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