SOCIOECONOMIC POSITION AND THE TRANSMISSION OF PSYCHOLOGICAL DISTRESS: A LIFE COURSE AND INTERGENERATIONAL ANALYSIS OF THE PANEL STUDY OF INCOME DYNAMICS

By

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ABSTRACT OF THE DISSERTATION

Socioeconomic Position and the Transmission of Psychological Distress: A life course and intergenerational analysis of the Panel Study of Income Dynamics

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Low socioeconomic position is associated with worse mental health, yet few studies have examined how socioeconomic patterning or fluctuations over the life course and across generations can influence later psychiatric symptoms. Using the Panel Study of Income Dynamics, we employed group-based trajectory modeling to examine how income trajectories over the life course and across generations impact psychological distress symptoms in both middle adulthood and among young adults. Decreasing income trajectories across the adult life course were associated with a higher prevalence of moderate/severe psychological distress in middle adulthood when compared to the highest income group; and middle to low and high to low intergenerational income trajectories from grandparents to their young adult grandchildren were associated with higher prevalence of moderate/severe psychological distress among young adults. Although the largest proportion of Black adults were part of the low and decreasing income trajectory, distress was highest among Blacks in the low but increasing income trajectory group. Our findings suggest that fluctuations in household income over the life course and across generations may influence current psychological distress to a greater degree than low but stable income trends when adjusted for other distress indicators.

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INTRODUCTION

Socioeconomic Position and Mental Health

The link between poverty and health has a well-established history. The so-called 'social causes' of disease came to light when poor sanitation and contaminated water made cholera, smallpox, and other infectious diseases leading causes of death in the U.S. and Europe. (Link & Phelan, 2006). Today, there is a robust body of evidence suggesting that even chronic disease and overall health is influenced by socioeconomic factors, including contextual effects such as neighborhood of residence in addition to individual-level risk factors. Moreover, there is increasing recognition that socioeconomic position (SEP) may capture the multiple ways in which social class, relations and ownership, as well as socioeconomic status, may influence health (Muntaner, et al 2004).

While there is much evidence supporting the direct effects of poverty on health, the complex process by which low SEP influences the development of health conditions that have a social and heritable component is less well understood. This is particularly true of psychological distress and the subsequent development of psychiatric conditions such as depression or anxiety. Risk factors for these conditions include genetic predisposition as well as environmental 'catalyzing' circumstances. For example, major depressive disorder (MDD) has been found to aggregate within families with a heritability as high as 37% (Fernandez-Pujals AM 2015; Sullivan, FP 2000). Since members of a family unit usually occupy the same socioeconomic class, the deep-rooted effects of chronic poverty or low SEP on the development of most psychiatric disorders can be difficult to tease apart from genetic or familial risk factors.

Differences in socioeconomic standing have been detected across a wide range of mental conditions, from schizophrenia to mood disorders such as depression and anxiety, with many studies showing higher rates of psychiatric conditions among those of lower socioeconomic standing. (Power 2002, pg 1989; Dohrenwend & Dohrenwend, 1974; Leaf, et al 1984; Lewis et al., 1998). Kessler (1994) was one of the first to find associations between education and a variety of psychiatric conditions. Compared to those with 16 or more years of education, "odds ratios for those with 12 or fewer were 1.79 for the presence of any affective or substance abuse disorder, and nearly four-fold higher for the presence of three or more psychiatric disorders of any kind" (Link & Phelan, 2006, pg 78).

Socioeconomic differences in mental health have generally been linked to either ***social selection*** or ***social causation*** hypotheses (Dohrenwend B, 1990, 1992; Power C, 2002). Health 'selection' occurs when the psychological status of the individual dictates their socioeconomic standing, such that those with severe disorders 'drift' downward on the socioeconomic scale, while healthier individuals who are able to work or attain more move upwards. Some researchers note that while ***social selection*** may play a more dominant role in psychotic disorders such as schizophrenia (disorders which can prevent individuals from achieving higher SES), the ***social causation*** hypothesis may figure more prominently into the development of depression, distress, and other affective or mood disorders (Dohrenwend et al 1992; Miech et al 1992; Power, 2002). However, because psychological distress precedes the development of both conduct and mood disorders as an early symptom, it may be difficult to distinguish which social hypothesis is at work.

Social causation posits that health differences are explained through the "experience of adversity and the presence of stressors given low socioeconomic status" (Power et al, 2002, pg 1990). This assumes SES precedes and causes access differences in factors relevant to mental health; such as family functioning, structure, parental involvement/stimulation and available support. Matthews and Gallo (2011) have since proposed a process wherein stressors brought on by SES coupled with a lack of psychosocial supports leads to negative emotions and heightened levels of psychological distress, which in turn can cause the 'immune alterations' which form the basis of subclinical or clinical disease (pg 530).

The social causation hypothesis is supported by literature which has examined earlier SES indicators and the prevalence of general distress and depression, (Harper et al, 2002; Power et al 2002; 1992) however, it is likely that elements of both selection and causation concurrently impact psychological distress to varying degrees. A higher prevalence of depression among persons of lower socioeconomic groups has also been noted by many researchers (Lorant, et al 2003, Link & Phelan, 2006), and similar studies have been conducted which have examined the direct association between low SES and increased psychological distress, particularly within proximal intervals of time.

The longer term or cumulative effects of low SEP on the development of psychiatric disorders, however, has only recently gained traction in the epidemiological and sociological literature. The strongest evidence regarding a potential independent effect of the social environment over time on psychological distress has also come from twin studies (Silberg JL et al, 2010) and more recently, from children-of-twin studies, which have shown that children of twins raised in distinct environments primarily learn

depressive and anxious behaviors directly from parents in the home, with a relatively smaller influence due to genetic predisposition (Eley T et al., 2014; Singh AL et al., 2011; McAdams TA 2015). This implies that the effects of the environment can persist over time, and the social environment can have distinct and discernible impacts on the adoption of health behaviors or symptom expression in offspring.

Life Course Models of SES and Chronic Disease

The development of chronic disease over the course of life has a long and rich research history. Early studies which have found an inverse relationship between birthweight and the later risk of cardiovascular diseases and hypertension have become known as "Barker's hypothesis" or the fetal origins of adult disease (FOAD) hypothesis (Barker and Osmond, 1986 in Tu & Gilthorpe, 2012). This hypothesis is based on how an "unfavorable environment, or insults during fetal life, might induce lifetime effects on the subsequent development of bodily systems and give rise to disease processes." (Tu and Gilthorpe, 2012; pg 98). Since then, this hypothesis has been expanded to include not only the fetal period, but growth throughout childhood, adolescence and beyond. This longitudinal incorporation of time, or growth throughout life, as equally predictive of disease risk is a cornerstone of life course epidemiology, which seeks to examine the "long-term effects of chronic disease risk of physical and social exposures during gestation, childhood, adolescence, young adulthood, and later adult life." (Ben-Schlomo and Kuh 2002, as cited in Tu & Gilthorpe, 2012).

The concept of the "etiologically relevant" or "critical" period (Ben-Schlomo and Kuh 2002; Rothman as cited in Eaton, 2006, pg. xiv) plays a key role in life course studies; in that exposures occurring at certain critical life periods influence the later

development of illness. While much life-course health research has focused on fetal or adolescent exposures in defining the 'critical exposure' period, "critical periods of varying duration exist throughout the course of life." (Opler; Costello; Cizza; as cited by Eaton W 2006, pg xiv). Eaton (2006) also points out that the critical period may "have a cumulative quality to it…and could take years or even decades to accumulate" until the exposure reaches a point of irreversibility and causally impacts health (pg xiv).

Most studies of SES are based on life course concepts. Because income, education, or wealth take years to accrue, and because current SES is based on the most recent past as well as early SES levels, a number of different life-course models of socioeconomic adversity have been proposed, most notably in the study of cardiovascular disease risk. (Pollitt, et al 2005). Pollitt (2005) outlines that four conceptual models of life course SES and disease exist. The "***latent effects"*** or ***"critical periods" conceptual model*** is most closely based on the FOAD hypothesis, which posits that low SES in early childhood (with early life as the "critical" period) increases the risk of chronic disease later in life, independent of intervening adult SES, lifestyle or other risk factors. (Pollitt, 2005, pg 2). Overall, these models stress the timing of the SES exposure as important; in that an exposure only has an outcome-related effect if experienced within a certain 'critical' time frame (Green and Popham, 2017).

The ***cumulative, accumulation or cumulative-exposure model*** hypothesizes that negative socioeconomic experiences and environments across periods of the life course accumulate to influence subsequent disease risk. Accumulation models posit that the duration, rather than the timing of the SES exposure as relevant to the health outcome. (Green and Popham, 2017). Generally, these models propose that each exposure has the

same effect on the outcome and that while "the impacts of different life course events accumulate they do not intersect" (Ben-Schlomo and Kuh, 2002, as cited in Pollitt R et al, 2005, pg 3). Since income, finances, or even socioeconomic standing may take years to accumulate, the cumulative model can be extended to focus on the overall shape of the income curve over the entire lifespan as a more complete indicator of the health outcome. Another extension of this is that the effects of socioeconomic experience accumulate not just across the individual life course, but across multiple generations to impact current health.

More dynamic models of life course SES have also been conceptualized. The pathway model emphasizes the effect of SES events along developmental pathways, implicating conditions at progressive stages of the life course in adult disease causation (Hertzman, et al 2001; Power and Hertzman, 1997). In particular, a developmental process has been proposed "where early experiences place an individual onto a certain 'pathway' or trajectory which then impacts their adult health." (Hertzman, et al 2001 as cited by Pollitt et al 2005, pg 2). In contrast to latent effects models, these models suggest that early life SES may not directly affect adult disease risk but is instead linked to adult outcomes through its influence on adult SES, or other more proximal SES measures in the pathway (Nandi et al, 2012).

Alternatively, the ***social mobility model*** hypothesizes that social mobility across the life course collectively impacts adult health. These models may incorporate both the intra-generational and intergenerational impact of SES on chronic disease risk; both in how family-level socioeconomic status during childhood affects adulthood socioeconomic attainment, and in describing the build-up or diminishment of

socioeconomic resources across generations to determine upwards or downwards social mobility. The relative shape of one's social mobility 'curve' is particularly important concept for mental health studies. The sequencing, or patterning of SES dips and spikes and fluctuations in social mobility has long been hypothesized to increase psychological distress as individuals struggle to adopt to unfamiliar social environments and norms (Sorokin PA, 1959 as cited in Houle and Martin, 2014, pg 2). Upwards social mobility, however, has been argued to "protect from later psychiatric problems by allowing individuals to acquire material/psychological resources which favor well-being" (Costello 2010; as cited in Melchior et al, 2017, pg 4).

Pathways and social mobility models of chronic disease development have been supported by numerous longitudinal studies, yet much SES life course research to date has not utilized these approaches. SES measurements are generally only taken once or twice, which has not allowed for the long-term operation of SES to be observed (Pollitt et al, 2005, pg 2). Much existing SES life course research is based on the latent effects model, where single and oftentimes retrospective assessments of childhood SES are entered into disease risk models as covariates, or simple cumulative exposure models, which average the effects of all exposures into a single variable. While socioeconomic disadvantage has been evaluated at single points of the life course, comparatively fewer life course measures have examined changes or cumulative effects of SES longitudinally from childhood to adulthood (Beebe-Dimmer et al 2004) within a social mobility context.

Mental Health Across the Life Course: A Review of the Literature

A burgeoning body of literature has demonstrated that living in poverty early in life is associated with worse physical/cognitive/psychiatric wellbeing later in life, even

after controlling for other risk factors (Luo and Waite, 2005, Gilman, SE 2003, Gilman SE et al 2002). Gilman et al (2003) found that low parental (i.e., childhood) SES and high levels of residential instability were related to elevated lifetime risks of depression in a sample of 1089 births, suggesting that childhood SES has lasting effects on health. However, key measures of SES were obtained only twice, once in infancy and once in childhood (at mother's enrollment and at age 7), and outcomes such as age of first depressive episode relied heavily on respondent recall, predisposing results to recall bias.

Luo and Waite (2005) improved upon this approach by assessing the effect of both childhood and adulthood SES on later physical, cognitive and mental well-being: lower childhood SES was associated with worse health outcomes later in life, with part of the effect occurring through childhood health, and a larger share of the effect being due to childhood SES working through adult education/income. The Luo and Waite study advanced what is known about SES effects over the life course, particularly with respect to how childhood SES may be mediated by adulthood SES to impact mental wellbeing in adulthood, a finding which has been replicated in other SES studies of chronic disease (Nandi, 2012). However, childhood SES and childhood health were obtained in adulthood through retrospective reports, with limited information available for the period from childhood to later adulthood, such that "potential pathways between early SES and later mental health" could not be ascertained (pg 100.)

Torres and Wong (2013) applied theories of latent (direct) and pathway (indirect) conditional effects in their analysis of nearly 9000 older adults in Mexico. They found that childhood poverty was significantly related to past-week depressive symptoms among older adults; this effect was partially mediated by adult SES measures such as

educational achievement. However, similar to previous life course studies of SES and depression, a single measure of childhood poverty was obtained (sanitation facilities in the home before age 10).

Wickrama and colleagues (2008) studied 500 adolescents from the Iowa Youth and Families Family Transitions Project (FTP) and examined the onset of depressive symptoms given childhood SES and familial adversity. They found that low SES/adverse experiences influence both the slope and growth of depression in adolescence, forming distinct segments of depressive symptom trajectories. Despite examining changes in symptoms over time, the analysis utilized a one-time measurement of childhood SES (parents' education). How changes in SES, or variations in the SES trajectory across childhood and adolescence may impact the development of depressive symptoms was not explored in the majority of studies. This is an important point, because "social mobility models suggest that variability or patterning of socioeconomic resource availability, in addition to 'absolute' measures of SES disadvantage, are associated with variations in disease risk." (Johnson-Lawrence V, et al 2015 pg 65; Lynch et al, Hallqvist et al, Tiikkaja et al, as cited by Johnson-Lawrence V et al).

Two recently published social mobility studies have looked at the association of parental SEP during childhood with adult mental health. Ward et al (2016) examined the association between educational mobility and depressive symptoms among those of Mexican origin by linking the highest educational level of individuals during adulthood with the highest educational level of their parents to define intergenerational mobility, which was then related to adult depression. Upwardly mobile participants were found to have the lowest depression scores when compared to those of 'stable low' mobility.

(Ward JB et al, 2016). Melchior et al (2017) also studied mobility in occupational grade from parents to their offspring and later adult antidepressant use in a large nationally representative cohort study in France. The odds of antidepressant use were higher among upwardly mobile and stable low occupational grade participants when compared to those of persistently high occupational grade, but parents' occupation was only measured at a single time period during adolescence and obtained retrospectively. (Melchior M, et al 2017). Both the Ward and Melchior studies were novel in that they captured a means of classifying social mobility across generations; but since both studies defined social mobility by using constant or single measures of SES, the effect of longer-term SES fluctuations or patterning on mental health outcomes could not be evaluated.

Another study included multiple measures of SES ascertainment and provided evidence for cumulative exposure hypotheses in mental health. Najman et al (2010) examined how family poverty over early life course periods is related to recurrent young adult anxiety. Family poverty was measured at four distinct periods (birth, 6 months, 5 years, 14 years) and it was found that poverty at 14 years was the strongest predictor of subsequent adolescent anxiety or depression (relative to the earlier life course periods). It was also found that the more frequently the child was exposed to poverty, the higher the risk of being anxious at follow-up, supporting hypotheses of cumulative SES exposures over the existence of early critical or sensitive periods for the development of anxiety/depression (Naiman et al, 2010).

Few studies to date have measured SES over multiple time periods, and fewer, if any, have incorporated both the cumulative measures of socioeconomic position *and* social mobility patterns throughout the life course as determinants of the risk of mental

distress. Part of this is complicated by the fact that SES can change over one's life span, so the use of time-invariant SES measures or cross-sectional databases may not fully capture the changes that might occur. Studies on cardiovascular disease and behaviors such alcohol use, however, have advanced what is known about cumulative effects and SES variation throughout the life course with the use of longitudinal income measures.

A study of cumulative socioeconomic disadvantage and cardiovascular disease mortality (CVDM) conducted over a 35-year period found that cumulative patterns of socioeconomic disadvantage influence CVDM more for women than for men. (Johnson-Lawrence et al 2015). SEP was measured both by fathers' education at baseline and as variations in household income over waves of data collection from 1965 to 1999, which covered both parent's income during childhood and later adulthood income. Not only is this type of operationalization of SES more comprehensive when determining the full weight of SES disadvantage, it also highlighted differential health effects for distinct subgroups of the population.

Cerda and colleagues (2011) created income trajectories with 29 years of data in order to evaluate the relationship between long-term and short-term measures of income and drinking and found that "lifetime income patterns may have an indirect association with alcohol use, which may be mediated by current socioeconomic circumstance" (pg 1178). This concept, where income exposures are experienced within the larger (or longer) socioeconomic context, may also apply to other psychiatric conditions. The occurrence of psychological distress, which can present as symptomatic 'episodes' throughout the life course (similar to bouts of drinking) may be influenced both by the

cumulative intergenerational pattern of socioeconomic disadvantage as well more immediate or proximal income fluctuations.

The Intergenerational Transmission of Psychological Distress through Socioeconomic Circumstance

A final element for understanding the long-term patterning of socioeconomic disadvantage and distress is considering how this operates not only over the life course but across generations. As outlined, life course studies of mental health have predominantly focused on latent childhood effects or pathway models of SES on later mental health. Fewer have conceptualized SES in a cumulative context or examined the enduring effects of low SEP on individual disease risk across multiple familial generations in a longitudinal setting. The reason for this gap is partly logistical in nature (Cohen AK, et al 2015). Only a small number of data sources have consistently collected data from the same set of core families for the extent of time necessary to span two generations for intergenerational research, much less three or more.

Studies of social mobility posit that the SES of the nuclear or immediate family "may not fully reflect the socioeconomic dis/advantages that may have built up along the family lineage, because people from similar socioeconomic backgrounds…may experience considerable heterogeneity in access to health resources depending on their grandparents' SEP" (Li M 2015 pg. 163; Chan and Boliver, 2013, as cited by Li M.) Furthermore, the degree to which resources or disadvantages are passed down through families and the ultimate effect on the health of later generations can differ based on demographic factors. Supporting multigenerational (e.g., grandparent to parent to grandchild) evidence of this phenomenon has already been found in studies of health

status and obesity (Le-Scherban 2014; Li, 2015). Using an approach similar to previous SES life course studies of cardiovascular disease mortality and alcohol use, Li (2015) used growth curve models to examine the association between grandparents' life course exposure to chronic poverty and grandchildren's BMI, with chronic poverty measured by 30 years of income data. Upon stratifying the models by sex, first generation exposure to chronic poverty independently increased the BMI of grand-daughters, a result which persisted after controlling for second-generation (parental) SES and BMI (Li, 2015). Using the same multigenerational database, Le-Scherban (2014) estimated the direct effects of grandparents' schooling on grandchildren's health status (independent of parental effects) and found that higher levels of schooling of grandparents benefited the health of grandchildren, especially among Whites (pg. 469).

Possible explanations for the transmission of psychological distress across generations due to low SEP have complex sociobiological origins. At the parental (second-generation) level, these include intrauterine mechanisms that affect mothers (second generation) and are transmitted to the developing fetus (third generation), epigenetic programming and behavioral risk factors present in early years. (Fox M, et al 2015). For example, parents who are poor may lack the skills or resources to effectively cope with life stressors, and thus transmit anxiety and a sense of hopelessness to their young children that eventually expresses itself as some degree of clinical distress in adult life. There is also evidence that individuals are more likely to experience the same distress-inducing exposures that their parents have; or are at least more likely to 'interpret' potential exposures that occur throughout their lifetime as traumatic or distress- inducing. By way of example, Roberts and colleagues (2012) found that children

of women who had PTSD (but were not exposed to the same trauma source) were more likely than children of women without PTSD to experience traumatic events, and even had a higher risk of trauma exposure themselves. (Roberts & Koenen K, et al 2012).

There is evidence that exposure to accumulated or persistent stressors such as SES insults can "disrupt physiological systems" (Vyas A et al, as cited by Ward J, 2016, pg 461). At the intergenerational level, stresses associated with poverty or lower socioeconomic status "may trigger a chain of risk events within the lineage of the family system that can result in the social/psychological maladaptation of the next generation" (Li, M 2015; Conger, et al 2010, as cited by Li, 2015, pg 168). Similarly, the 'learned' circumstance or the cumulative disadvantage of the earlier generations may manifest itself as heightened distress and lower psychological wellbeing in third-generation offspring, independent of direct risk factors in more 'proximal' generations. Whether or not there is a genetic predilection towards mental illness, the premise is that children can learn to express distress-related behaviors in response to similar socioeconomic triggers.

Purpose of the Doctoral Dissertation and Study Rationale

The purpose of the present dissertation research is to address gaps in current investigations of life course studies as they relate to psychological distress. Although existing studies have provided new evidence on disease etiology and prevention efforts centered on addressing early life social conditions, at least two important gaps exist in the literature. First, no study of which we are aware has examined the socioeconomic patterning of distress symptomology across multiple generations, incorporating up to 40

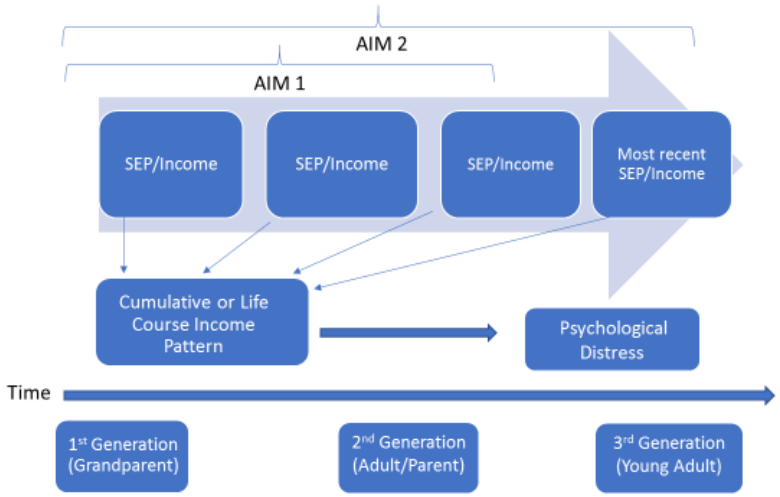
years of data. This expansive use of data allows for a more nuanced investigation of SEP patterns over time, and their relationship to psychological distress symptoms.

Secondly, most life course studies to date have used time-invariant socioeconomic measures or have taken SEP assessments at single or limited points in time and have not determined if changes if socioeconomic changes over the life course influence the development of psychological distress in distinct ways. Given that individuals can experience substantial income changes over their lives and may cycle in and out of poverty, how these changes result in later distress symptoms has not been thoroughly explored. Lastly, little is known about the extent to which intergenerational and life course measures of SEP may jointly affect psychological distress for any given individual. The impact of SEP on distress may be experienced differentially given a particular social mobility context and for certain sub-groups of the population over others.

Conceptual Models

The proposed core conceptual model for this doctoral dissertation is based upon aspects of ***social mobility*** and ***cumulative exposure*** models of SES (**Figure 1**). It incorporates both time-varying changes and overall cumulative effects of socioeconomic position across the lifetime and highlights how SEP is 'patterned' over time to influence distress**.**

Figure 1: SEP and Distress: Over the Life Course and Across Generations



This abridged conceptual model captures longitudinal measures of SEP (such as income) and constructs patterns summarizing these measurements over time (Aim 1) and across families (Aim 2). The model covers the cumulative income pattern of adults, and the life course and multigenerational component for adolescents or young adults-- the latter being "the period of highest risk of the onset for common mental disorders (Eaton W, et al 2001, pg 3). For aim-specific conceptual model adaptations, see Figures 1a and 1b (in Appendix A).

Income or SEP measures accumulate over time to generate the cumulative or life course pattern of socioeconomic dis/advantage which impacts an individual's future psychological distress. Since the overall shape of the income curve over the life span may be a better indicator of distress risk, the cumulative approach includes the most recent or

proximal income/SEP measures as part of one's social mobility pattern, as depicted above.

Figure 2: SEP, Distress and Selected Variables of Interest

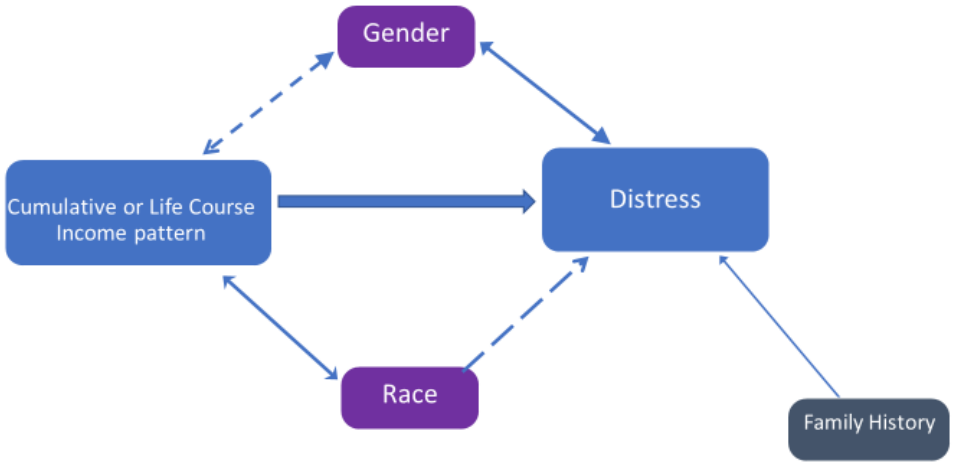


Figure 2 outlines the relationship between SEP, distress and selected variables of interest. There are a number of third variables which can influence the strength of the SEP and distress relationship or independently predict distress. For example, race is associated with socioeconomic disadvantage, and African-Americans have been found to have the highest odds of psychiatric symptomology (when unadjusted for socioeconomic factors and access to care). (Bromberger JT et al, 2004). There are also gender differences in depression and anxiety rates, with girls being more likely to experience symptoms than boys, and with earlier symptom onset (Nolen-Hoeksema and Girgus, 1994; as cited in Dekker M et al 2007).

Direct risk factors for distress (such as family history of depression or other psychological disorders) will be controlled or otherwise accounted for to better determine the direction of the SEP/depression relationship. Few existing studies of socioeconomic status and mental disorders have included data on individual or family background of the mental disorder, "such that estimation of an independent SES effect may potentially be biased. (Eaton W, et al 2001, pg 2).

Specific Aims and Hypotheses:

A burgeoning body of literature has demonstrated that socioeconomic disadvantage early in life is associated with the development of worse physical and psychological wellbeing later in life, even after controlling for established risk factors. Nonetheless, the complex process by which low socioeconomic position (SEP) influences the development of health conditions that have a social and heritable component is less well understood. This is particularly true of psychiatric conditions, including depression, mood disorders and distress, which have been shown to have a familial/genetic link as well as social determinants foundation. Several mechanisms have been proposed to explain how low SEP influences health, including a 'pathways' model that emphasizes developmental SES experiences, a 'social mobility' model that examines variations in SES context, and a 'cumulative exposure' model, which proposes that disease develops as a result of an accumulation of negative SEP circumstances over the life course. However, many life course studies have not thoroughly tested these models, limiting investigations of the long-term effect of social disadvantage on health. Finally, few studies have investigated the enduring effects of low SEP on individual mental health across multiple familial generations.

The present doctoral dissertation aims to comprehensively assess how patterns in socioeconomic disadvantage are associated with risk of psychological distress over time, blending social mobility and cumulative exposure models. We use the Panel Study of Income Dynamics (PSID), a longitudinal study of the U.S. population that includes detailed measures of income and other demographic characteristics, plus distress symptoms assessed with the K-6 instrument. The study examines the long-term effect of SEP over a person's life and across three generations. The specific aims of this doctoral dissertation are:

Aim 1: To assess how variation in income over the life course is associated with psychological distress symptoms in adult life. Hypothesis 1: Low household income trajectories and greater fluctuations in income over the life course will be associated with higher prevalence of psychological distress. To address this aim, models will be fit to identify latent income trajectories and examine associations with mental distress in middle adulthood.

Aim 2: To investigate the cumulative effect of intergenerational income on distress in young adulthood. Hypothesis 2: Downward changes in income between grandparents and parents will be associated with higher prevalence of psychological distress in third-generation young adults, while stable or increased income between the prior two generations will be associated with lower distress. This aim expands on Aim 1 by examining income data over multiple generations and adding the effect of grandparents' income on an individual's symptoms during young adulthood. Distress will be adjusted for psychiatric diagnoses reported in earlier generations.

Aim 3: To explore if the association between life course income and distress symptoms differs based on sex or race. Aim 3 expands upon prior aims by examining subgroup differences.

Understanding when and how symptoms of mental distress develop due to low socioeconomic position would advance causal interpretation of this growing area of research, and particularly the role of intergenerational effects on mental health. The study also has implications for the design of interventions that can mitigate the detrimental effects of early life exposures, and the need to tailor therapeutic approaches for adults suffering from psychiatric conditions.

Methods

PSID Data Source and Supplementary Files

The PSID is the world's longest running nationally representative panel survey. Because it's genealogically designed with nearly 50 years of data on the same families and their descendants, it is ideal for life course (intra-generational) and intergenerational research. PSID follows every individual born or adopted into the original sample families and "yields a continuously representative sample of children born into US families." (McGonagle KA et al, 2012). The data is organized as the Main Interview file and various supplementary files, which collect data on over 5000 core families (more than 18,000 individuals) on items including income, health, and relationships. Each core family unit/family member is linked by a unique family identification number, which identifies individuals of the same family over generations of data. Since 1968, data has

been collected from over 10,000 families as descendants have formed their own family units.

Main Interview

The main interview (or core family PSID file) covers all income and educational measures on families over time. Between 1968 and 1997, interviews were conducted annually, but since then interviews have been biennial (every 2 years). While information about each individual within the family unit is collected at each assessment in the main interview, additional information is obtained from the household head and "wife" or cohabitating partner/spouse. (PSID website, Main Interview: https://psidonline.isr.umich.edu/Studies.aspx, 2017). Various measures of family income and other SEP measures such as head/wife education and household head employment have been consistently measured since 1968, and additional measures of mental health status, such psychological distress in the past 30 days, depression, anxiety, and any psychiatric diagnoses have been measured biennially since 2001.

For this study, Aim #1 will utilize information collected from main family interviews over a 35-year period up until 2015 (the most recent wave of the main interview). Current heads of households and wives in middle adulthood will be sampled and linked by unique identification number to family-level SEP variables as well as individual-level demographic variables in the individual data index. All sampled household heads and wives can have income trends which span over two generations, with at least three years of parents' income data potentially included in their life course income trend.

Transition into Adulthood Supplement (TAS)

In 1997, up to two children from each main interview household between 0 to 12 years old were included and followed up separately in the Child Development Supplement (CDS). Beginning in 2005, and up until the present available data wave (2015), the Transition into Adulthood Supplement (TAS) has continuously enrolled CDS children when they become 18 years of age. (PSID, TAS: https://psidonline.isr.umich.edu/Studies.aspx, 2017). Information collected from TAS young adults includes measures of time use, psychological functioning, marriage, family, responsibilities, employment and income, education and career goals and health. Additionally, family-level (such as household income data) and individual-level variables can be linked back to each young adult and merged by year with corresponding TAS data with a unique personal and family identification number. There are currently 6 biennial TAS assessments, from 2005-2015. In addition to psychological distress in the past 30 days (K-6 instrument, described below), the TAS file queries respondents on any physician-diagnosed psychiatric/emotional disorder(s) as well as 12-month depression. For Aim #2, TAS young adults between 17-20 years of age will be linked to SEP and income measurements from their parents and grandparents in the main family interviews to span three generations of data.

Measures: Variable Definitions and Operationalization

Primary Outcome: The Kessler-6 (K6) screening scale is a measure of psychological distress which consists of 6 questions on depression and anxiety symptoms the respondent has experienced in the past 30-day period scored on a 5-point Likert scale, from none of the time to all of the time. (Kessler R, et al 2003). Designed as a screening

tool for severe mental illness in the population (Wittchen HU, 2010), it has since been validated in patient samples and may supplement diagnostic criteria in clinical practice. It has shown to be accurate in the ability to discriminate between DSM-cases and non-cases on mood disorders (Prochaska, et al 2012; Kessler, 2002) and performs well with respect to sensitivity and specificity relative to the CIDI-SF (Composite International Diagnostic Interview, Short Form) for depression. (Cornelius BL, et al 2013). The scale consists of 6 questions which query respondents on sadness, nervousness, restlessness, hopelessness, feeling everything an effort and worthlessness. Although the K-6 is not specific regarding the types of psychiatric illness it picks up, four of the six K-6 items overlap with four of the nine symptoms of depression according to the DSM-V, and the other two (restlessness and nervousness) are anxiety symptoms which may indicate depression per DSM criteria.

Scoring for the K-6 consists of converting the six item scores to a 0-24 scale, where responses for each question are coded from 0-4 and summed. While a cut-point score of 13 and above is considered the optimal cut point for assessing the population prevalence of severe mental illness (Kessler, et al 2003), other applications have included collapsing scores into strata of mental illness or distress. Previously defined cut-offs posit that scores of 0 to 4 indicate no or mild distress, scores of 5 to 12 indicate moderate psychological distress, and scores of >=13 indicate severe psychological distress. (Kessler et al, 2003; Prochaska et al 2012, as cited in Le-Scherban, F et al 2016, pg. 800). Other studies using the K-6 instrument have collapsed scores into mental illness strata, where 0 are no symptoms, scores 1-7 indicate low symptoms, scores 8-12 indicate mild to

moderate symptoms, and scores of >=13 indicate serious mental illness (Furukawa et al, 2003; Kessler et al 2010a as cited in Bjorkenstam et al 2015, pg 111).

For the purposes of this study, a slightly more conservative threshold criterion was used as qualifying for moderate psychological distress; K-6 scores were dichotomized so values of 0 to 7 indicated no or mild psychological distress, and scores of 8 to 24 indicated moderate or severe psychological distress. This was done to improve the specificity of clinically relevant moderate psychological distress among young adults (who are twice as likely to have increased levels of non-specific mild psychological distress compared to adults) but maintain adequate sensitivity to capture measurable increases in distress in older adult populations (who may not yet be at the point of serious mental illness.)

The K-6 instrument is administered from 2001 to 2015 in the PSID main interview (at 7 occasions, every 2 years except 2005), and biennially in the TAS from 2005 to 2015).

Primary Predictor: The primary exposure or explanatory measure for these analyses is family or household income. Household or individual income is one of the best SEP indicators of material living standards and access to resources at most phases of the life course (Galobardes, Shaw, Lawlor et al, 2006, pg 10; Galorbardes B, et al 2007). Like other SEP measures, income has been suggested to have a cumulative effect on health over the lifetime (Lynch JW, et al 1997 as cited in Galobardes 2007, pg 29); but unlike other more static SEP indicators such as education, income is an important time-varying component of SEP which is the most sensitive to change in the short-term. This makes it ideal for the operationalization of cumulative exposure models and a more accurate

indicator of social mobility which has not been extensively studied or used in the SES & health literature.

For all study aims, total household taxable and transfer income for each year during the lifetime study period for each respondent will be used. Each income measure is equivalized to account for household size, adjusted for inflation using the CPI-W (Consumer Price Index for Wage Earners) in 2014 dollars and log-transformed for each year of collection. These repeated income assessments/measurements form the basis of the overall income trajectory or trend. Any household income occurring during the childhood of a sample respondent (e.g., parental income) will be linked to later adult respondent income by the unique household identification number assigned to all generations of PSID households.

For Aim 1, income trajectories of middle-aged adults (aged 35-50) in 2015 over the previous 35-year period will be estimated to form distinct groups income trends over the life course. The resulting trajectories are coded into summary variables representing the income trajectory of that respondent. This income trajectory variable is then added as a covariate into a larger model predicting the prevalence of psychological distress among adults in 2015. This income trajectory variable captures both the shape of the income trend as well as the overall impact of income across an extended period of the life course to help predict psychological distress in 2015.

For Aim 2, grandparents' and parents' household income trajectories will be combined with young adult life course household income trajectories, to form a single intergenerational income trajectory for each young adult describing the pathway from grandparent to parent (young adult life course) to child income. Intergenerational income

trajectories are useful because they are single variables which summarize the directional movement between two or more generations and allow for the categorization of the resulting income trend. The resulting intergenerational income trajectory variables similarly capture both the shape of the intergenerational income trend and the impact of these trends across more than two generations.

Statistical Analyses

The statistical methods described here include the key analytic approaches which are common to all three aims of this research project.

Group-based Trajectory Modelling (GBTM): Estimating outcome trajectories has been used in developmental psychology or sociology studies, where patterns of change in an outcome across multiple time points are modeled (Nagin, 2005). Grouped trajectories have also been used with other outcomes which are known/hypothesized to follow differing patterns over time, particularly when the variables causing the patterning are latent, or unknown or unmeasurable.

Latent class or group-based trajectory modeling is a fairly new approach (2000) for modeling longitudinal data developed by Nagin, Jones and Roeder which are closely related to hierarchical modeling and growth curve models. (Jones, et al 2001). However, unlike standard growth models, which assume individuals change in the same direction over time, GBTM assumes that subgroups in the population follow a *multinomial* pattern of change, in that both the direction and magnitude of change varies by person over time. (Nagin, 2002; as cited in Andruff, H. et al, 2009, pg 12). In other words, rather than modelling the population average or covariance function around the mean, the group-

based trajectory approach models individual variable trajectories around the mean and clusters individuals with similar trajectories into groups.

Each individual has a probability of being in each group and individuals are grouped according to where the probability of their observed trajectory is highest. In this way, group-based trajectories are useful for modeling unobserved heterogeneity in a population and are semi-parametric, in that they assume that a mixture of probability distributions can describe the totality of data to be analyzed. (Jones, et al 2001). The formula for a group-based trajectory model of a censored normal probability distribution is: $\left(y_{it}^{*}\right) = \beta_0^j + \beta_1^j \mathrm{X}_{it} + \beta_2^j \mathrm{X}_{it}^2 + \beta_3^j \mathrm{X}_{it}^3 + \varepsilon_{it}$, where each trajectory is described as a latent variable (Y_{it}*) that represents the predicted score on a given (continuous) dependent variable of interest (Y) for a given trajectory (j) at a specific time (t). For the purposes of this research project, our dependent variable Y represents household income. X, X^2 and X^3 represent the independent variable, which can have linear, quadratic and cubed terms, and β_0, β_1 and β_2 are the parameters defining the intercepts and slopes of the trajectory for that specific subgroup (j). (Andruff, H et al, 2009, pg 13). The core predictor (X) for GBTMs is time (eg, study year or age). The significance of each trajectory is compared using a nested modeling approach, where the model with more trajectories (or higher order terms) is compared to a simpler model of fewer trajectories and lower order terms. Nested models are compared using an estimate of the log Bayes Factor defined by the following: $2\log_e\left(\mathrm{B}_{10}\right) \approx 2\left(\mathrm{BIC}\right)$ and the BIC of the simpler model is subtracted from the BIC of the more complex model (Andruff H et al, 2009).

A procedure called Proc Traj is capable of modeling and charting group-based trajectories directly in the SAS platform. Proc Traj identifies clusters of individuals following similar progressions of an outcome over time or time unit by fitting a group-based model and is available for free-download at http://www.andrew.cmu.edu/~bjones. (Jones, B, 2007). Proc Traj can be used to estimate a range of specific (outcome) probability distributions, including censored normal, binomial logit, and Poisson. The maximum number of distinct trajectories (or groups) are pre-specified by the researcher, and the model with the number of trajectories that best fits the data is selected. Posterior probabilities are then used to assign each individual the trajectory that best matches their profile change over time.

In general, the Proc Traj modeling procedure consists of fitting 2 group models of quadratic or cubic order and increasing the number of groups until optimal model fit is obtained (Jones BL, 2007). Groups are sequentially added, balancing optimal BIC (fit), maximum differentiation in trajectories (and highest individual probabilities of group placement) and parsimony (noting the n in each group). Substituting higher order terms for lower order terms for groups that lack statistically significant parameter estimates may then be used to improve the fit of the final model. Upon model finalization, each trajectory can be qualitatively labelled or named by the researcher, either empirically according to value or relatively given the other groups.

Extensions of the Proc Traj procedure can accommodate the addition of time-varying or time stable covariates (also called “risk factors) into the core trajectory model as additional predictors. Risk factors act as predictors of trajectory group membership, so it is assumed that they coincide with the initial time period of the trajectory. (Jones and

Nagin, 2007). They answer the basic question: "Does group membership probability depend on the time stable factor?" The inclusion of time-varying covariates, on the other hand, predict the shape of the trajectory according to the value of the covariate at each time of measurement. The underlying research question here is: "How does the addition of the covariate shape the trajectory itself?" (Jones B, email communications, 2017). We will adjust our core income trajectory model for both a time stable and a time-varying covariate in supplementary analyses included in Aim 1 of this project. Adult income trajectory curves will be adjusted for having ever reported a diagnosis of (any) psychiatric condition as a risk factor covariate 'predicting' the income trend; income trajectory curves will also be adjusted for household head or wife status at each income assessment as a time-varying covariate.

For the purposes of both Aims 1 and 2, analyses consist of a two-part modeling approach as outlined in other studies of income trajectories and health outcomes (Cerda M et al, 2011; Johnson-Lawrence V et al, 2015). First, the types of lifetime income trends respondents follow will be estimated by the group-based approach and operationalized using the Proc Traj procedure. Each income assessment collected will make up the observed outcome trajectory, with the primary independent variable being time- operationalized as study year in Aim 1 and participant age in Aim 2 of this project. As outlined by the conceptual cumulative exposure-based model, household income will be collected from the start of the study period (either calendar year or birth year) up until the most proximal income assessment preceding the measurement of psychological distress.

Distinct income groups obtained from the GBTM procedure then become primary explanatory variables in a log-binomial regression model predicting moderate or severe psychological distress in the index year or study wave, or otherwise following the completion of the income trajectory in time, which is the second part of the modeling process. By using the income group or trend as the main exposure, the effect of both the income level and the average change in income over time on distress risk can be ascertained. In addition to the income trajectory group exposure variable, regression models will be adjusted for demographic characteristics, other SEP indicators (education, occupation), any psychiatric diagnoses of the participant (or any diagnoses occurring in previous generations), and other risk factors for distress among adults (Aim 1) or young adults (Aim 2). All log-binomial regression models will be fit with an exchangeable correlation matrix to account for within-family clustering of observations and correct standard error estimates, and prevalence ratios (ie, risk ratios) and 95% confidence intervals will be presented.

In order to examine whether the association between (life course) income trend and distress symptoms differs based on sex or race (Aim 3), an income group*race or income*sex statistical interaction term will be added to log-binomial regression models. P-values for the interaction term and prevalence ratios for distress for each income group and at each racial/ethnic or gender stratum will be reported. Any potential heterogeneous effect estimates will be presented and graphically depicted.

MAIN BODY

Paper 1:

Life course Income Trends and the Prevalence of Psychological Distress among Adults

Introduction

Most studies examining the risk of depression, anxiety and other psychiatric conditions as a result of socioeconomic conditions have focused on income measurements taken at distinct timepoints in childhood. Although research has linked early childhood socioeconomic circumstance to later adulthood mental health (Luo and Waite, 2005; Torres and Wong, 2013), "critical exposure periods can occur throughout the life course" (Eaton W, 2006 pg xiv) and when these critical periods occur may vary among individuals.

Income in particular is the considered the single "best indicator of material living standards" (Galobardes, Shaw, Lawlor et al, 2006, pg 10) and can influence physical and mental health throughout the life course. Income can have a direct effect on health through access to material resources and services or indirectly through education, behavior change, and prevention (Galobardes, Shaw, Lawlor et al 2006). However, given that income flow is a continuously changing phenomenon, the effects of income on health may also fluctuate throughout one's lifetime (Eaton, 2001). Studies that examine the risk of psychological distress in a period such as middle adulthood as a result of a single exposure period likely miss the complex process of income's influence on health. Distress or depressive symptoms appearing later in life are influenced by early (childhood), middle, as well as later (adulthood) financial circumstances which

accumulate (Lynch, Kaplan, and Shema, 1997 as cited in Cerda, pg 1179). Moreover, studies which have examined income or other socioeconomic indicators and present health status have been complicated by an assumed unilateral direction between socioeconomic factors and health. How pre-existing illness may affect one's economic circumstance has not been investigated in most cases; this is particularly relevant for studies of mental health.

The present paper investigates how variation in income over the life course is associated with psychological distress symptoms in adult life. We hypothesize that low household income trajectories and greater fluctuations in life course income will be associated with a higher prevalence of psychological distress among adults. We will also examine how being diagnosed with any psychiatric condition can influence both income-generating potential and the prevalence of psychological distress.

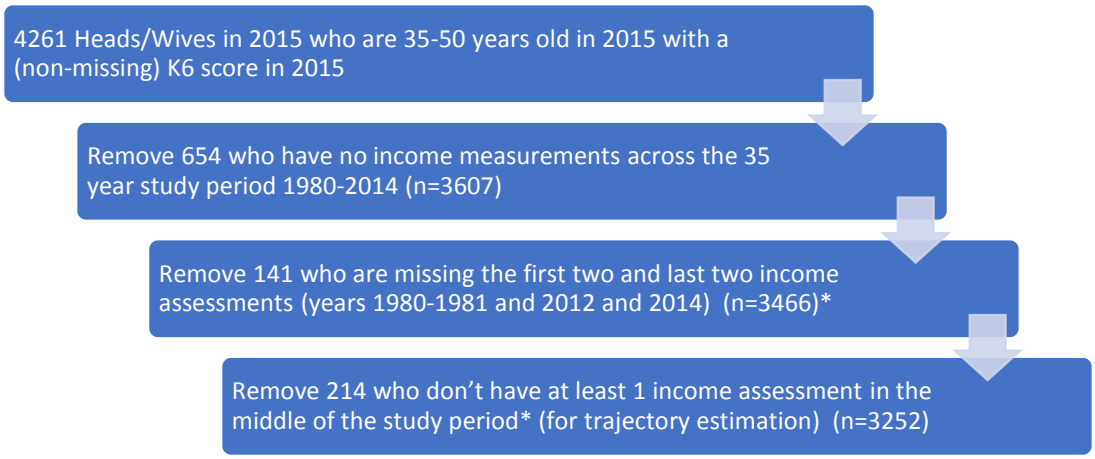
Methods

Study Sample: We used the Panel Study of Income Dynamics (PSID) family interview file as the sampling frame to select our study sample. The PSID is a multi-generational database of 5000 sampled families beginning in 1968, which has since grown to over 10,000 family units. Once offspring of family heads of wives leave their original households and form their own households, these new households are also followed by the study.

Our analytic sample consisted of 4261 heads and wives between 35 and 50 years of age who had a non-missing psychological distress score in the 2015 study wave.

Yearly household family income for each head/wife respondent over the past 35-year period was collected, from 1980 to 2014. As such, the income measures collected spanned different life course periods given the current age of the 2015 respondent. 1009 participants without at least three key income assessments[1] over the study period were also removed, for a final sample of 3252 adults. While respondents could have no less than three income assessments, all participants in the current sample had at least nine (9) income assessments between the beginning (1980) and end (2014) of the study period. (See Figure 1).

Figure 1: Sample Selection of PSID Adults



Measures: The main outcome variable was psychological distress score in 2015 as measured by the six-item Kessler Psychological Distress Scale (K6). The scale ranges from scores 0-24, with scores of 13 or more considered positive for severe mental illness. (Kessler, et al 2003). We created a binary variable, where scores of 8-24 indicated

[1] Sample selection procedure for GBTM of income closely follows that outlined by Cerda, M et al in "Lifetime income patterns and alcohol consumption: Investigating the association between long and short-term income trajectories and drinking". *Soc Sci Med.* 2011 October; 73(8): 1178–1185.

moderate to severe psychological distress, and scores of 0-7 indicated no or mild symptoms.

The primary exposure variable was total household income in the past year for each sample participant. Total household income was defined as the sum of taxable and transfer income of the head, wife, or any other wage earner in that household, and was adjusted for family size (equivalized), adjusted for inflation using the Consumer Price Index in 2014 dollars (CPI-W) in each year of collection, and log-transformed. Any negative income reported (eg, net losses) were given a value of 1 prior to inflation adjustment and log transformation. Study participants have income measurements from the time they are part of a PSID household and are assigned a unique id number (at birth). They are linked to other household income measures as they form their own households and become heads and wives. In this way, household income measures are continuously linked to individual respondents regardless of which household they currently reside in. The sample selection procedure ensured all individuals in this sample had at least 3 years of intergenerational income (parents' household income), regardless of the respondent's age in 2015 (eg, a 50-year old would have parental income from 15 to 18 years old).

Other covariates such as highest level of education, current occupation of household head, marital status[2], and whether the respondent reported having ever received any psychiatric/nervous/emotional disorder diagnosis were assessed in 2015, when psychological distress scores were also measured.

[2] SEP covariate selection informed by Cerda M et al. "Lifetime income patterns and alcohol consumption: Investigating the association between long and short-term income trajectories and drinking". *Soc Sci Med.* 2011 October; 73(8): 1178–1185.

Statistical Analyses: The main analytic procedure for this study was group-based trajectory modeling run with the Proc Traj procedure on the SAS platform. Informed by other published literature of income trajectories and health outcomes/behaviors, (Cerda M et al 2011; Johnson-Lawrence V et al 2015) analyses for this study consisted of a two-part modeling approach. First, group-based models were used to estimate the household income trajectories of participants in the previous 35-year period from 1980 to 2014 as a function of the explanatory variable, time or study year. The censored normal parametric distribution was used to model the log of household income, and a series of two to six group trajectory models of cubic order were fit to determine the number of groups that best summarized the data given the sample size[3]. Distinct income groups were obtained after model fitting, which became the primary explanatory variable ("income trend") in a second log-binomial regression model predicting moderate/severe psychological distress. As such, the resultant income group variable "captured both the levels and fluctuations in household income" into a single variable measured before the occurrence of adult psychological distress (Cerda M, et al 2011, pg. 1179).

Descriptive statistics were presented as frequencies, percentages (weighted to account for the sampling design), and standard errors, or means and standard errors for continuous or categorical variables, respectively. A series of log-binomial regression models were fit and prevalence ratios and corresponding 95% confidence intervals for moderate or severe distress were estimated. The prevalence of distress was presented for the unadjusted model, where the income trend group was the only covariate, and

[3] GBTM fitting procedure as applied by Johnson-Lawrence, VD et al, 2015 in "Cumulative socioeconomic disadvantage and cardiovascular disease mortality in the Alameda County Study 1965 to 2000." *Annals of Epidemiology.* 2015; 25: 65-70.

subsequent models which were adjusted for demographic characteristics, other SEP indicators, and having ever had any diagnosis of a psychiatric/emotional/nervous disorder. All log-binomial regression models were fit with an exchangeable correlation to account for the pairing of household heads and wives, and a model-based method was used for the adjustment of standard error estimates. Analyses were also weighted for the 2015 study year (the year of outcome measurement).

Sensitivity analyses were conducted which adjusted the core trajectory model for head/wife status in each study year (as a time-varying covariate) and whether any psychiatric diagnosis had ever been reported by heads or wives (as a time stable covariate, or risk factor). In the case of household status, this was done to assess how changes from household dependent to head/wife status at each study year might shape the trajectories, since we would expect newly formed households to experience different income fluctuations than previously established ones. We also adjusted income trajectory models for the presence of any psychiatric diagnos(es) ever received, as reported by heads and wives in 2015. This was done to determine how much group membership probabilities were affected by the potential reverse causality between mental illness and income potential. Finally, although we fit accumulation models and lifetime income groups included all income assessments up to and including past-year income quartile, a post-hoc analysis which adjusted for past-year income quartile was conducted to assess the direct or independent effects of life course income group trend.

All statistical tests were two-sided at the $\alpha=0.05$ significance level, and analyses were conducted in SAS Version 9.4 (SAS Institute, Cary, NC) and SAS-callable SUDAAN, Version 11.0.1, to account for the complex sampling design of the PSID.

Results

The individual and household characteristics of the adult sample are presented in Table 1. Respondents were 51% female, on average 43 years old, and the majority were White (84.7%). Approximately 12% reported moderate or severe levels of psychological distress in 2015, and 12.3% reported ever having received a diagnosis for a psychiatric, nervous or emotional disorder.

Table 1: Weighted Individual and Household Characteristics of PSID Heads and Wives, 2015

	Analyzable Population* (n=3252)		Full Study Population* (n=14004)	
	Total N	% (SE); *Mean (SE)*	Total N	% (SE); *Mean (SE)*
INDIVIDUAL CHARACTERISTICS				
Female	1744	51.0 (0.67)	7691	52.8 (0.41)
Age 18-29	-	-	639	9.6 (0.46)
30-44	2217	60.1 (1.20)	2379	21.5 (0.63)
45-59	1035	39.9 (1.20)	3646	30.0 (0.51)
60-74	-	-	4826	27.0 (0.58)
75+	-	-	2513	11.8 (0.41)
Age	*3252*	*42.7 (0.10)*	*14004*	*50.8 (0.31)*
White	1997	84.7 (2.12)	8335	81.7 (1.46)
Black	1132	12.9 (2.00)	4621	11.6 (1.29)
Other	63	2.3 (0.55)	762	6.6 (0.63)
Educational Level: <HS	191	4.8 (0.78)	1252	8.6 (0.59)
HS Degree	887	25.8 (1.36)	4310	29.9 (0.96)
Some College	786	22.9 (1.11)	3060	20.3 (0.56)
College Degree	771	27.0 (1.21)	3023	24.5 (0.73)
Post-graduate	514	19.3 (1.06)	1856	16.6 (0.70)
Years of Education	*3149*	*14.3 (0.09)*	*13501*	*13.8 (0.07)*
Psychological/nervous/emotional diagnosis (ever)	352	12.3 (1.02)	1386	10.8 (0.42)
K6 Score (0-24)	*3252*	*3.2 (0.13)*	*13794*	*3.0 (0.66)*
K6 PD[1] Category: 0: None	1044	31.1 (1.45)	4649	34.9 (0.68)
1-7: Mild	1812	57.3 (1.25)	7397	54.0 (0.73)
8-12: Moderate	277	7.9 (0.74)	1243	7.7 (0.41)
13+ : Severe	119	3.7 (0.48)	505	3.2 (0.26)
HOUSEHOLD CHARACTERISTICS				
Household Head	2130	64.6 (0.70)	9343	67.6 (0.40)
Marital Status: Married	2114	67.7 (1.30)	8131	60.5 (0.92)

Single	557	15.2 (0.81)	3339	18.1 (0.63)
Div/Widow/Sep	581	17.1 (1.04)	2533	21.3 (0.67)
Occupation (Head): White Collar	1231	44.5 (1.81)	4154	33.0 (0.81)
Pink Collar	569	17.2 (1.14)	2221	14.5 (0.48)
Blue Collar	1172	31.9 (1.52)	4903	30.2 (0.73)
Unemployed	214	6.4 (0.64)	2334	22.3 (0.74)
Past year Income Quartile:				
Quartile 1: 1-29,999	547	13.4 (1.23)	3464	21.6 (0.86)
Quartile 2: 30,000-58,834.4	687	17.8 (1.18)	3538	24.0 (0.62)
Quartile 3: 58,834.5-101,049	887	26.9 (1.38)	3499	25.1 (0.56)
Quartile 4: 101,050 +	1131	41.8 (1.90)	3503	29.2 (0.98)

***** Analyzable population includes heads and wives aged 35-50 with non-missing K6 score in 2015 and at least 5 family income measurements over the past 35 years, full study population is all heads/wives in 2015. 1=psychological distress

The majority reported being household heads (65%), married (68%) and 62% were employed in white or pink-collar (service-oriented) professions. A large proportion reported that their household income in 2014 was or exceeded $101,050 (41.8%); a finding consistent with other studies also using PSID data (Li M, 2015).

Results for the group-based trajectory modeling procedure are in Tables 2A and 2B and Figures 2a and 2b below. After fitting a series of models of two to six trajectory groups, a five-group solution was chosen where the 1st and 4th groups were modified from cubic to quadratic order to improve the significance of the parameter estimates and model parsimony. (See Appendix B, Graphs A-I, Table J, Trajectory Model Fitting Process). All average group membership probabilities ranged from 91% to 97%, meaning that the probability that an individual's lifetime income trend best fit their specific group placement exceeded 90% in all cases. (Table 2A).

Table 2A: Parameter Estimates for 5-Group Log Income Trajectory Model for Adults (N=3252)

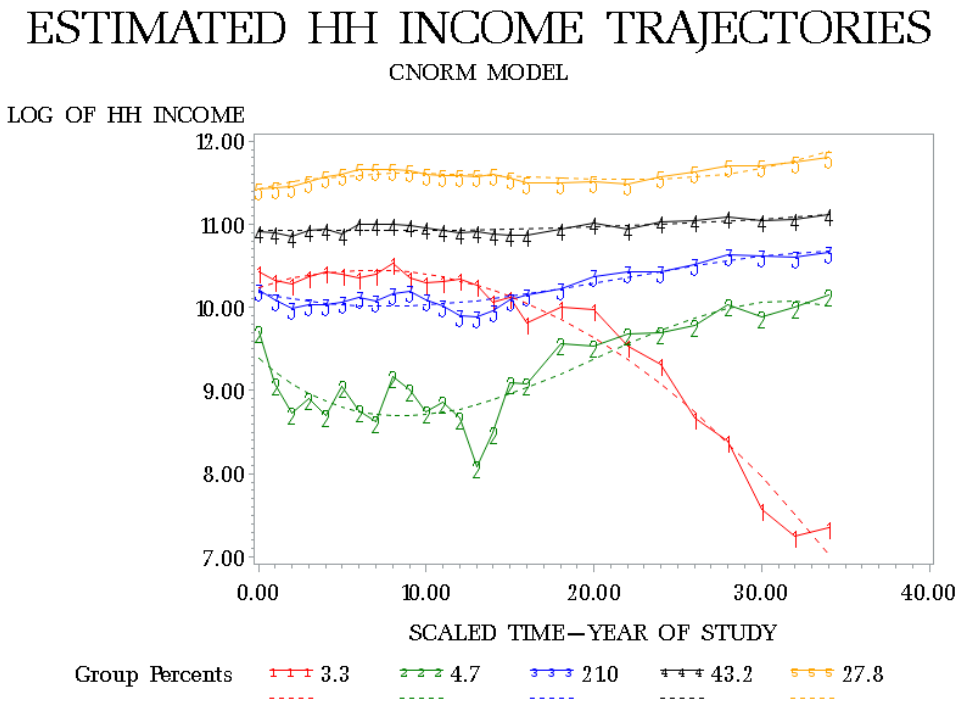
Group	Average group probability	Parameter Term	Estimate	Standard Error
1	0.95	Intercept	10.244*	0.09
		Linear	0.061*	0.01

		Quadratic	-0.004*	0.00
2	0.97	Intercept	9.388*	0.05
		Linear	-0.180*	0.01
		Quadratic	0.014*	0.00
		Cubic	-0.000*	0.00
3	0.93	Intercept	10.180*	0.03
		Linear	-0.047*	0.00
		Quadratic	0.003*	0.00
		Cubic	-0.000*	0.00
4	0.91	Intercept	10.930*	0.01
		Linear	-0.003	0.00
		Quadratic	0.000*	0.00
5	0.92	Intercept	11.430*	0.02
		Linear	0.045*	0.00
		Quadratic	-0.003*	0.00
		Cubic	0.000*	0.00

**p<0.0001;* Sigma: 0.92216; SE: 0.00230; Model BIC=-114602.1 (N=3252)

Figures 2a and 2b depict the log-transformed household income trajectories for the sample (Figure 2a) and the same five income trend groups converted to 2014 dollars (Figure 2b). The largest percentage of respondents fit into Group 4, labelled the 'stable middle' income group (n=1428, 44%), followed by high income (27%, n=884), low to middle increasing (21%, n=682), very low income (4.6%, n=151) and finally the low to middle decreasing income group (3%, n=107). (Table 2B).

Figure 2a: Household Log-Transformed Income Trajectories for PSID Respondents aged 35-50 years old in 2015 (Study Years: 1980-2014)*



*Model predicting household income, adjusted for time (study year)

Figure 2b: Respondent Household Income Trajectories from 1980 to 2014, in 2014 dollars

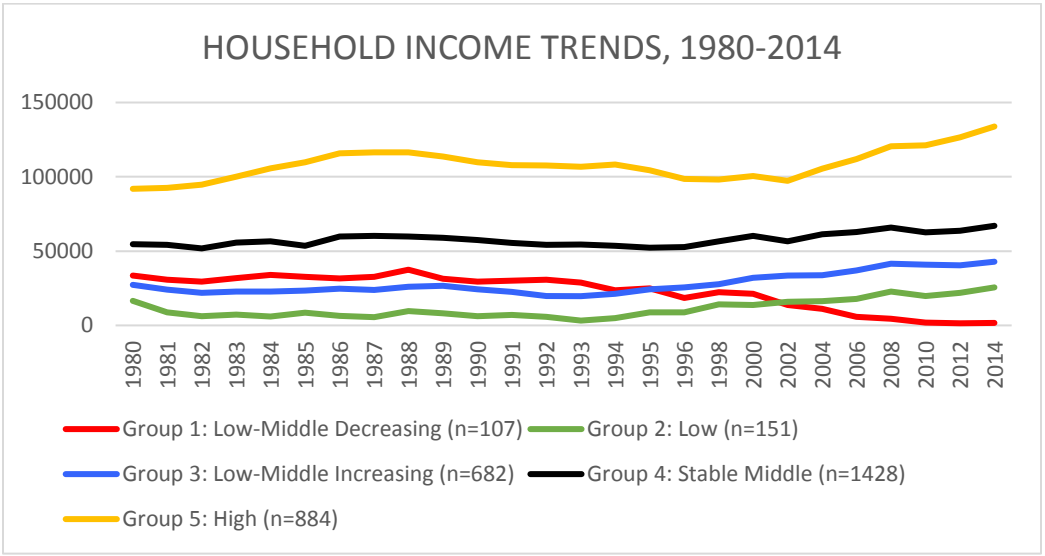


Table 2B: Income Group Membership for Adults, Unadjusted Model (N=3252)

Group	Frequency	Membership %	Standard Error	95% CI
1: Low-middle Decreasing	107	3.29	0.44079	(2.42, 4.15)
2: Low	151	4.64	0.40456	(3.84, 5.43)
3: Low-middle Increasing	682	20.97	0.97353	(19.06, 22.87)
4: Stable Middle	1428	43.91	1.12611	(41.70, 46.11)
5: High	884	27.18	1.24654	(24.85, 29.62)

The results of the regression modeling appear in Table 3 below. When compared to the high-income group, the low to middle decreasing income group had the highest prevalence of psychological distress in middle adulthood (prevalence ratio (PR): 8.34; 95% CI: 5.01, 13.89), followed by the low, low-middle increasing, and stable middle-income groups. These associations were attenuated but remained statistically significant after adjusting for demographic characteristics and ever having had any psychiatric diagnoses. In the fully adjusted model, the low to middle decreasing income group was nearly three times as likely to experience moderate to severe psychological distress compared to the highest income group (adjusted PR (aPR): 2.63; 95% CI: 1.29, 5.35); followed by the very low or low to middle income decreasing groups where distress was twice as prevalent as in the high income group (aPR: 2.05; 95% CI: 1.07, 3.93 and aPR: 2.03; 95% CI: 1.12, 3.66, respectively). Corresponding odds ratio estimates for all adjusted model covariates are included in Appendix C.

Because our income modeling approach followed a cumulative exposure hypothesis, full models did not additionally for past-year income quartile to avoid collinearity and because proximal income points can be considered mediators in the income trend-distress causal pathway.

Table 3: Association of Life Course Income Group with Prevalence Psychological Distress Among Adults 35-50 years old, PSID 2015*

	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]
	PR (95% CI)[d]	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)
Income Group				
Low-mid decreasing	8.34 (5.01, 13.89)	6.99 (3.78, 12.92)	2.69 (1.18, 6.14)	2.63 (1.29, 5.35)
Low	4.44 (2.39, 8.26)	3.78 (1.66, 8.60)	2.35 (1.07, 5.17)	2.05 (1.07, 3.93)
Low-mid increasing	4.17 (2.52, 6.91)	3.94 (2.22, 7.01)	2.54 (1.35, 4.77)	2.03 (1.12, 3.66)
Stable Middle	2.79 (1.73, 4.50)	2.70 (1.62, 4.50)	2.04 (1.29, 3.23)	1.78 (1.20, 2.64)
High	1.00	1.00	1.00	1.00

*Models fit with exchangeable working correlation and robust variance estimation (SEs).

[a] Model 1 adjusted for demographics: age (in years), race, sex, marital status

[b] Model 2 adjusted for SEP indicators: current occupation of head, educational level

[c] Model 3 presents income group prevalence ratios for the fully adjusted model- additionally adjusted for any psychiatric/emotional/nervous disorder diagnosis. Models unadjusted for household head status (collinearity-marital status) and past year income quartile (collinearity-income trend, potential mediator, predicted by prior income trend)

[d] PR=prevalence ratio, 95% CI=confidence interval

Sensitivity Analyses

Key results upon adjusting the trajectories for head/wife status are shown in Table 4 and Figure 3. When adding head/wife status as a time-varying predictor in the trajectory modeling process, a five-group solution was estimated (data on file, not shown). Since the effect of the head/wife status variable could vary among trajectory groups, differential effects were apparent among group-specific parameter estimates (Table 4). In group 1, which is here the lowest income trajectory, the parameter estimate for the head/wife term (HDWF) was positive and statistically significant, indicating that the transition to household head or wife among the lowest income group is associated with increased income when such status shifts occur. On the other hand, membership in the low to middle decreasing, stable middle or high household income groups indicate that transitions to head or wife status for individuals in these groups is associated with a decrease in household income, as evidenced by the negative parameter estimates for the HDWF term in the respective groups.

Table 4: Parameter Estimates for 5-Group Log Income Trajectory Model Adjusting for Head/Wife Status

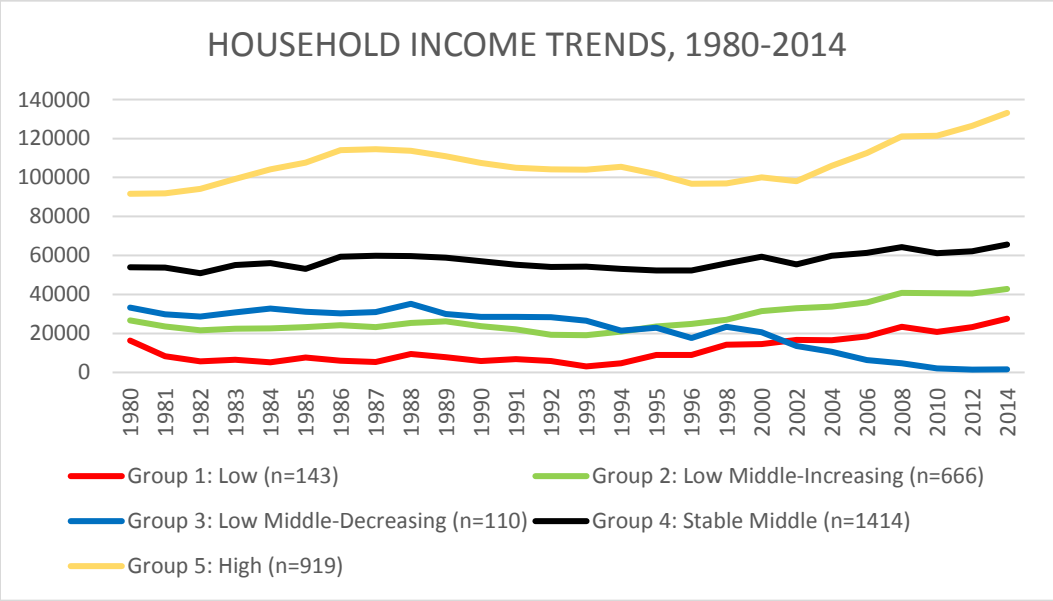
Group	Average group probability	Parameter Term	Estimate	Standard Error
1	0.96	Intercept	9.321*	0.06
		Linear	-0.183*	0.01
		Quadratic	0.013*	0.00
		Cubic	-0.000*	0.00
		HDWF	0.389*	0.53
2	0.93	Intercept	10.164*	0.02
		Linear	-0.048*	0.00
		Quadratic	0.003*	0.00
		Cubic	-0.000*	0.00
		HDWF	-0.025	0.03
3	0.97	Intercept	10.319*	0.05
		Linear	0.007*	0.00

		Quadratic	0.001*	0.00
		Cubic	-0.000*	0.00
		HDWF	-0.664*	0.06
4	0.91	Intercept	10.901*	0.02
		Linear	0.002	0.00
		Quadratic	0.000*	0.00
		HDWF	-0.191*	0.01
5	0.92	Intercept	11.447*	0.02
		Linear	0.027*	0.00
		Quadratic	-0.001*	0.00
		Cubic	0.000*	0.00
		HDWF	-0.314*	0.02

**p<0.0001;* Sigma: 0.91976; SE: 0.00228; Model BIC=-114398.8 (N=3252)

The groups that emerged from the trajectory modeling process upon head or wife household status adjustment otherwise did not differ from the income trends estimated in the core model. While transitioning to head of household status had a negative effect on income for most groups (with the strongest effect among the highest income group; HDWF estimate= -0.314), it did not affect either the shape or number of income groups estimated (Figure 3).

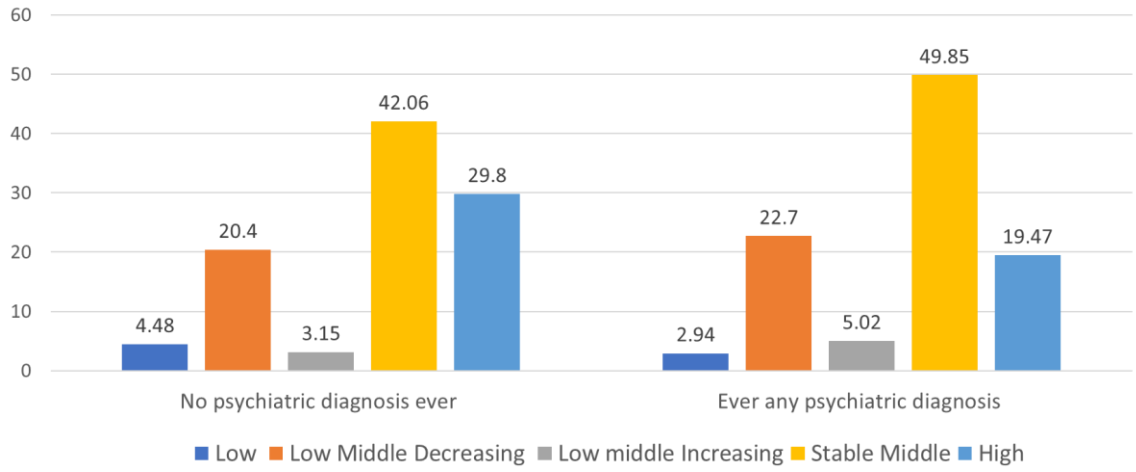
Figure 3: Respondent Household Income Trajectories, Adjusted for Head/Wife Status



Log-binomial regression modeling of psychological distress yielded similar results to those estimated by household-status unadjusted trajectory models (Appendix D).

We also adjusted the trajectory model for the presence of any psychiatric diagnoses a risk factor for income potential and to observe if membership probabilities of the 5-group model changed. A graphical depiction of the effect of the psychiatric diagnoses risk factor on the five income trajectory groups appears in Figure 3.

Figure 4: Effect of Any Psychiatric Diagnoses on Group Membership Probabilities



When trajectories were adjusted for any psychiatric diagnoses reported, a fair amount of individuals moved out of the high income trajectory, as evidenced by the difference in membership probabilities in the unadjusted and adjusted models (High income probability (*p*)=0.298 vs. adjusted high income probability (a*p*)=0.195).

Most moved into the stable middle-income trajectory (*p*=0.421 vs a*p*=0.498), and the remainder moved into the lower income fluctuating groups. There was no increase in group membership for the lowest income group. While there was some movement of individuals among income groups as a result of this adjustment, the distributional

changes to income groups was not substantial enough to attribute income potential entirely to social selection phenomena, at least when underlying psychiatric disorders are measured by psychiatric diagnoses received.

Finally, the results of the post-hoc sensitivity analysis are presented in Table 5. Here, past-year income quartile is the primary exposure variable in Model 1, and the life course income groups are added to Model 2. The p-value corresponding to the Wald chi-square statistic corresponding to the income group variable in Model 2 is $p=0.1362$, indicating that the income group regression parameter is not significantly different than zero in a model already adjusted for past-year income quartile. Model fit seems to improve somewhat with the addition of the income groups variable, as evidenced by the adjusted F-test for the overall model. The difference in the Hosmer-Lemeshow F-test statistic between the two models suggests that the addition of income trend variable in Model 2 results in an incrementally better fit.

It is important to note that the independent increase in model fit or predictive power corresponding to prior life course income trend cannot be disentangled completely from past-year income quartile, as income trajectory modeling included all available income measures up to and including prior year income to construct income trend groups, per the hypothesized conceptual model. The conceptual model was based upon a cumulative exposure framework, and as such, no formal mediation analyses were done.

Table 5: Sensitivity Analysis: Past Year Income with Life Course Income Group Adjustment and Prevalence Psychological Distress

	Model 1[a]	Model 2[b]
	PR (95% CI)	PR (95% CI)
Income Quartile		
1-29,999	4.35 (2.47, 7.65)	3.69 (2.08, 6.56)
30k-58,834.4	2.45 (1.45, 4.12)	2.08 (1.25, 3.47)
58,834.5-101,049	1.35 (0.78, 2.33)	1.19 (0.69, 2.05)
101,050+	1.00	1.00
Wald Chi-square (income group)		6.99 (*p=0.1362*)
Adj. F-test (overall model)	49.78 (*p<0.0001*)	52.71 (*p<0.0001*)

[a]Model 1 adjusted for demographics: age (in years), race, sex, marital status, current occupation of head and educational level, any psychiatric diagnos(es)

[b] Model 2 adjusted for age (years), race, sex, marital status, current occupation of head, educational level, any psychiatric diagnos(es) and life course income group

Discussion

Our study examined household income trajectories over a 35-year period of the life course and related this to present-day psychological distress in middle-aged adults. Consistent with our a priori hypothesis, those belonging to a lower and decreasing, or low and fluctuating income trend were significantly more likely to experience elevated psychological distress compared to those in the high-income group, and distress was least prevalent among the highest income group when compared to any other (lower) income group. This relationship was attenuated but remained significant after adjusting for other

socioeconomic indicators (occupation, educational level) and any reported psychiatric disorder diagnoses.

As with prior mental health research, this study found that socioeconomic disadvantage across the life course was associated with worse mental health in adulthood (Luo and Waite, 2005; Gilman SE et al 2013; Torres and Wong, 2013); and specifically, that downward changes income trajectories were associated with higher psychological distress. Recently published studies have found similar downward associations between educational or occupational mobility and depressive risk among adults (Ward J, et al 2016; Melchior M et al 2017). However, our study is novel in that we examine time-varying measures of SEP such as income longitudinally over a 35-year period. As such, we were able to capture the full effect of longer-term SEP fluctuations throughout child and adulthood on psychological distress. In addition to the potential for detrimental mental health effects of downward income trajectories, we were also able to observe a somewhat enduring protective effect of being in a stable income group throughout the life course when compared to a more fluctuating trajectory. These findings, at the minimum, highlight the importance of stable financial prospects for families or extended financial support for those who face episodes of income loss.

Our sensitivity analyses supported our main findings. Controlling income models for the transition to household head or spouse status allowed us to more accurately determine the influence of individual household income history on new families. We also explored if reverse causality/social selection biases may explain our findings by adjusting income trajectory models for the presence of any psychiatric diagnoses reported by

participants. The results of our sensitivity analyses helped to explain some of the variation in income trajectories and their impact on group membership, but neither adjustment could fully predict either the number or shape of distinct income trajectories formed. Household status transitions or psychiatric diagnoses alone did not seem to be particularly strong predictors of income trends in this population.

The stepwise addition of covariates to distress models allowed us to observe incremental attenuations in the life course income group and distress relationship. Prevalence ratios for the life course income groups remained high after adjusting for demographic characteristics, but substantially decreased when adjusted for other SEP factors such as highest level of education and current occupational status. This indicates that perhaps more stable SEP measures can modify the impact of even time-variable income fluctuations on mental distress. Corresponding odds-ratio estimates for the education and occupation terms show that having less than a high school degree or being unemployed increase the odds of distress by two-fold and more than two-fold when compared to having a post-graduate degree or employment in a white-collar profession, respectively, in adjusted models. By extension, this implies that higher levels of education or white-collar employment may protect against some of the detrimental health impacts of lower income regardless of income group membership; however, decreases in distress as result of these adjustments were most prominent in the low-decreasing income trajectory group. Upon controlling for having ever been diagnosed with (any) psychiatric disorder, effect estimates for all income groups decreased further but remained elevated and statistically significant, indicating that income trends independently affect

psychological distress despite adjustment or educational level, occupational status, or any (pre-existing) predilection towards distress symptoms that the respondent might have.

There are several limitations of our study which deserve mention. As noted by Cerda M and colleagues in their study of income trajectories in the PSID dataset (Cerda M et al, 2011) our sample selection of 35 to 50-year old adults and the measurement of their income trends between 1980-2014 captured income from different stages of the life course for respondents depending on their age in 2015. We captured life course income from birth to the present time for 35-year olds, and from age 15 to the present time for 50-year olds (and all age ranges in between for individuals who were greater than 35 and less than 50 years old.) There is likely a differential influence of income trends spanning such a wide range of life stages on present day distress, particularly if 'critical periods' of income exposure occur more frequently in early childhood.

On the other hand, a smaller sample age range would have reduced our analytic sample size and would not have allowed for as many different patterns of income to emerge from the data. It was also important for the current study to include later measures of economic advantage or disadvantage as well as earlier ones given that the effects of income tend to accumulate over time. Later or proximal income measures were particularly critical to capture within the income trajectory, in that they are frequently direct consequences of earlier economic circumstance. Our primary interest was in testing cumulative exposure and social mobility models of SEP and health, with the recognition that critical periods may vary among adult individuals or later in life.

Because current heads/wives in 2015 were asked if they had ever been diagnosed with a psychiatric condition but the age at which they were diagnosed was not captured, our control for psychiatric diagnoses in income trajectory models only partially, if not incompletely, controlled for the impact of psychiatric illness on income-generating potential. This, coupled with the fact that higher income individuals may be more likely to receive and thus report psychiatric diagnoses, prevented us from adequately controlling for reverse causality between income and mental health status or estimating its exact effect across the entire 35-year income trajectory. Finally, as also noted in the Cerda paper (2011), while our psychological distress model adjusted for the correlation between heads of households and their corresponding wives, the Proc Traj procedure assumes that observations are independent, and thus cannot account for clustering between head/wife pairs. As a result, standard errors associated with trajectory model parameter estimates may be underestimated, which may have affected group membership probabilities.

In conclusion, this is the first study to examine 35-year life course income trajectories and the prevalence psychological distress in adulthood and use a large, nationally representative, longitudinal database with information on multiple family generations to do so. It is also one of few to examine how psychiatric status may affect both pre-existing income trends and mental health outcomes in adulthood. Future research should continue to explore the inter-relationships between income, education, occupation and other SEP indicators in order to accurately describe the relationship between socioeconomic disadvantage and mental health over time.

Paper 2:

Life course Income and the Transmission of Psychological Distress Among Young Adults: An Intergenerational Analysis

Introduction

Low family income and other measures of socioeconomic position (SEP) over the early stages of the life course have been found to influence psychological well-being in young adulthood. For example, poverty across distinct periods in childhood has been linked to recurrent young adult anxiety (Naiman et al, 2010) and higher average family wealth during childhood has been linked to less psychological distress among young adults (Le-Scherban F, et al, 2016). Despite this, little is known about how income fluctuations both across the early life course and across multiple generations affect young adult mental health.

Specifically, intergenerational studies of obesity and low birthweight have shown the enduring effects of SEP on these health metrics across generations. (Li, M 2015; Le-Scherban F et al, 2014). For example, grandparents' SEP can directly influence parental socioeconomic position, which can then affect the health status of children (i.e.grandchildren). In this way, studies which focus solely on the effects of low childhood SEP on young adult health status may be incomplete, in that they ignore the economic insults or resources that may have accumulated in families over time. While prior research has examined the intergenerational effects of parent education or occupational status on offspring depression (Ward J 2016; Melchior M 2017), no study of

which we are aware has examined the intergenerational effects of income for two or more generations in relation to young adult (third generation) mental health. This is important-because young adulthood is the time when "emotional and cognitive maturation combined with a transition in social roles" (Sawyer 2012, as cited in Le-Scherban F 2016, pg 798) as well as life circumstance can create a critical exposure period for development of psychiatric disorders. The onset of three-fourths of psychiatric illness occurs by the age of 24 (Kieling et al 2011 as cited in Le-Scherban F 2016, pg 798) and studies have identified childhood poverty as an important catalyst for mental health problems into adulthood. (Pascoe, 2016).

In a prior study (Paper 1), we showed how 35-year income trajectories from earlier to later in the life course were associated with psychological distress in middle adulthood. However, our analysis was hindered by the inability to measure distinct stages of the life course from birth to the present time for all participants. In the present paper, we will model longitudinal associations between young adult household income (or parental income trajectories) from birth to the present time, and their grandparents' preceding income trends to investigate the cumulative effect of intergenerational and life course income on psychological distress symptoms in young adulthood. We hypothesize that downward changes in income between grandparents and parents will be associated with higher prevalence of psychological distress in third-generation young adults, while stable or increased income between the prior two generations will be associated with lower distress. Thus, this paper expands upon our prior work by examining income changes over distinct stages of the individual life course and over multiple generations.

Methods

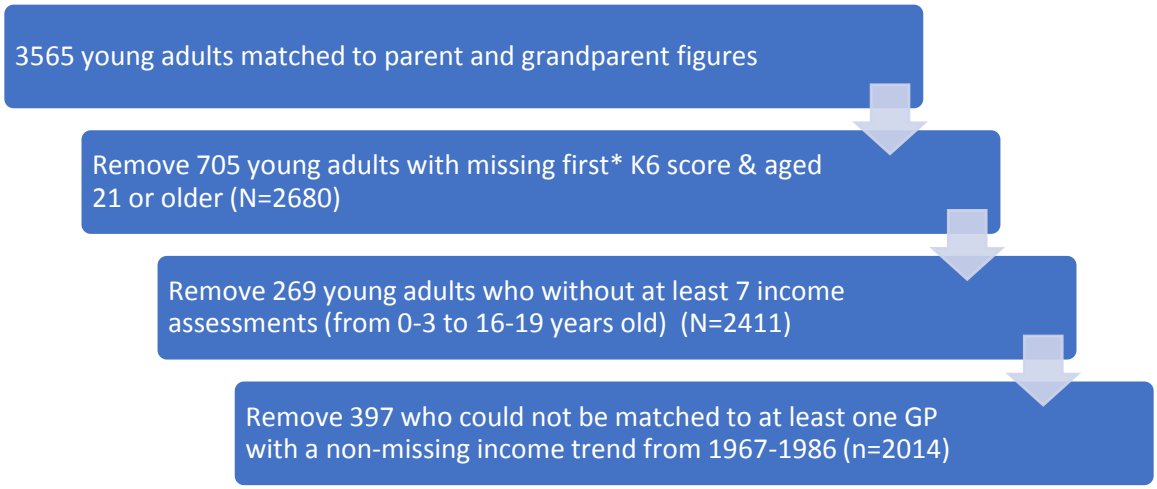
Data: The data for this study was drawn from the Panel Study of Income Dynamics (PSID) Transition to Adulthood Supplement (TAS) and the PSID Main Interview (family files). The TAS, started in 2005, collects key measures of psychosocial wellbeing and other data biennially on young adults from PSID families when they turn 18. Young adults are continuously enrolled in the TAS as they become eligible and there are currently 6 waves of data available (PSID; https://psidonline.isr.umich.edu/Studies.aspx). TAS sample members were intergenerationally linked to both their biological and adoptive parents and grandparents in the PSID family files using the Family Identification Mapping System (FIMS) (https://psidonline.isr.umich.edu/VideoTutorial.aspx#.) Each young adult was linked to up to two parent records and up to four grandparent records in the main interview which included information on family-level variables, such as occupation, education, and household income.

Study Sample: A total of 3565 young adults from all TAS waves were matched to their parent(s) and grandparent(s) from the mapping procedure. (Figure 1). After removing 674 young adults whose K6 psychological distress score was missing at their first assessment, 2691 remained. Upon removing those aged 21 or older and those who did not have at least 7 income assessments over the life course[4], the final analytic sample for life

[4] The age range was restricted to 17-20 to capture parental income trajectories before the transition to adulthood; 7 was the minimum number of income assessments needed to span all stages of the life course from birth or infancy to 16 years of age for all participants.

course models included 2411 young adults aged 17 to 20 years old. The final sample for intergenerational income trajectory analyses was based on 2014 young adults matched to at least one grandparent with a non-missing income trend over a 20-year period (from 1967 to 1986).

Figure 1: Young Adult Study Sample Selection Procedure



*First K6 score could occur in any of the 6 TAS waves (2005, 2007, 2009, 2011, 2013, 2015) dependent on year of entry into TAS (eg, index year).

Measures: The primary outcome variable was young adult psychological distress score as measured by the Kessler 6-item Psychological Distress Scale. This was ascertained in all six available TAS waves, from 2005 to 2015. The scale was dichotomized into none/mild distress symptoms (scores 0-7) and moderate/severe psychological distress (scores 8 to 24).

The primary exposure variable was based on yearly household income, or all taxable and transfer income equivalized per family size in the past year. All income measurements

were log-transformed and adjusted for inflation per the CPI-W (Consumer Price Index-Wage Earners) in 2014 dollars. The 20-year household income trend of grandparents were then linked to the life course household income trajectories of their young adult grandchildren to construct six categories of family intergenerational income trajectories (IIT): high-high, high-low, middle-high, middle-low, low-high and low-low[5]. The final family IIT variable was thus a summary variable of six categories, reflecting both the absolute level and mobility of household income across generations. In order to create the ITT variable, the young adult trajectory solution from group-based trajectory modeling (described further below) was merged into a smaller number of groups and linked to the most parsimonious group solution of grandparents, noting the number of levels of the IIT term. The resulting six-level composite variable described each distinct income trajectory from grandparents (3 levels) to adolescents (summarized to 2 levels).

Statistical Analyses: Group-based trajectory modeling using the Proc Traj procedure in SAS was used to construct both the 1.) life course household income trajectories of young adults (including that of their parents) and 2.) the income trends of their grandparent(s). For young adults, each income assessment for trajectory formation was dependent on their distress study wave, or K6 index year. For example, a 17-year old in index year 2005 would have family income in 1987 (their year of birth) as the first income point in their trajectory, whereas a 20-year old in 2005 would be 3 years old at

5 Similar to the approach used by Ward JB et al in "Intergenerational educational mobility and depressive symptoms in a population of Mexican origin". *Annals of Epidemiology.* 2016; 26: 461-466.

the time of their first income assessment. A range of calendar 'birth' years (from 1987 to 1997) was selected for each of the 6 TAS study waves in order to capture the life course income (within a 3-year interval) for each selected young adult. Thus, trajectory models were used to estimate the life course household income trajectories of young adult participants from birth to age 3, and to 16 to 19 years old as a function of the explanatory variable, age.

Group-based trajectory models were also used to model the household income trend of matched grandparents during a 20-year interval before the individual's year of birth (from 1967 to 1986). Since most young adults were linked to (at least one) non-missing grandmother figure, in cases where more than one grandparent with non-missing income information could be mapped to each young adult, the paternal grandmother's household income was used first, followed by the maternal grandmother's, followed by grandfather's information (if available) in order to create the income trend. These trajectory models were used to estimate the household income trajectories of grandparents from 1967 to 1986 as a function of the explanatory variable, time or study year. As in our first paper, for both the young adult and grandparent trajectories, the censored normal parametric distribution was used to model the log of household income, and a series of two to six group trajectory models of cubic order were fit to determine the optimal number of income groups that best fit the data.

Descriptive statistics were presented as frequencies, (weighted) percentages, and standard errors, or means and standard errors for continuous or categorical variables, respectively. A series of log-binomial regression models were fit to estimate the

risk/prevalence of moderate or severe psychological distress during the K6 index year or study wave. The prevalence of young adult distress was presented for unadjusted models, where life course income or IIT category was the only covariate, and subsequent models which were adjusted for 1.) young adult demographic characteristics such as index/survey year, race, sex, age category, and current relationship status 2.) parent characteristics, including marital status and whether any psychiatric diagnosis was ever reported by (any) parent and 3.) parents' highest level of education. Models were unadjusted for past year household income quartile because it was included within the income trajectory, and any young adult diagnosis of psychiatric disorder, as this might have been tapping into the same theoretical construct as psychological distress. A sensitivity analysis of grandparents' income trend and third-generation distress accounting for parent characteristics and young adult life course income was also conducted.

All log-binomial regression models were fit with an exchangeable correlation matrix to account for within-family clustering of observations; this could occur between grandparents, parents, and children, and also between young adult siblings. A robust model-based variance estimation method was used for the adjustment of SE estimates. All analyses were weighted and sample weights for each participant were constructed from individual TAS study wave weights corresponding to the K6 index year.

Statistical tests were two-sided at the $\alpha=0.05$ significance level, and analyses were conducted in SAS Version 9.4 (SAS Institute, Cary, NC) and SAS-callable SUDAAN, Version 11.0.1, to account for the complex sampling design of the PSID.

Results

The sociodemographic and clinical characteristics of the young adult sample (n=2411) are displayed in Table 1. The majority of the sample was White (68.4%), on average 18 years old and 45% reported currently being in a romantic relationship. Roughly 13% reported having being diagnosed with a psychological, nervous or emotional disorder, 15% reported being depressed for two weeks or more in the past year, and the average K6 score was 5, indicating mild psychological distress.

Table 1. Weighted Characteristics of Young Adult Sample (PSID-TAS)

	Sample TAS Population* (n=2411)	
	N	Weighted % (SE); *Mean (SE)*
Female	1240	49.8 (0.9)
Non-Hispanic White	1151	68.4 (2.8)
Non-Hispanic Black	1009	16.7 (2.1)
Non-Hispanic Other	47	2.8 (0.5)
Hispanic	195	11.9 (1.6)
Age at first K6 score	*2411*	*18.46 (0.02)*
Psychological/nervous/emotional diagnosis (ever)	241	12.9 (0.9)
Index Year: 2005	591	24.2 (1.0)
2007	330	15.2 (0.9)
2009	387	15.5 (1.2)
2011	421	15.8 (0.9)
2013	391	13.0 (0.9)
2015	291	16.1 (1.1)
First K6 Score (0-24)	*2411*	*5.28 (0.08)*
K6 PD[1] Category: 0: None	191	6.2 (0.6)
1-7: Low	1668	71.5 (1.3)
8-12: Mild/Moderate	422	17.2 (1.1)
13+ : Severe	130	5.1 (0.5)
Depressed for >=2 weeks in the past 12 months	353	14.5 (0.9)
Romantic Partner: Yes	1111	45.3 (1.8)
Past-year HH Income Quartile[N]:		
Quartile 1: 1-31,432	557	16.8 (1.1)
Quartile 2: 31,433-61,693	585	21.1 (1.2)

Quartile 3: 61,694-113,999	612	26.8 (1.3)
Quartile 4: 114,000 +	657	35.2 (2.0)

*****Sample TAS population includes young adults 17-20 years old at the time of their first K6 score and with at least 7 household income assessments from birth-3 to 17-20 years old. 1=psychological distress, N: adjusted to 2014 dollars.

The results of the group-based trajectory models for young adults are presented in Tables 2A-2B, and Figures 2a-2b. A 5-group solution was chosen from fitting a series of two to six group models (see Appendix E). The 5th group parameter estimates were changed from cubic to quadratic order to improve model fit, and group membership probabilities ranged from 87% (Group 4) to 99% (Group 2). (Table 2B).

Table 2A: Life course Income Group Membership of Young Adults (N=2411)

Group	Frequency	Membership %	Standard Error	95% CI
Group 1	127	5.27	0.493	4.30, 6.23
Group 2	50	2.07	0.290	1.50, 2.64
Group 3	80	3.32	0.418	2.50, 4.14
Group 4	758	31.44	1.518	28.46, 34.41
Group 5	1396	57.90	1.584	54.79, 61.00

Table 2B: Parameter Estimates for 5-Group Log Income Trajectory Model for Young Adults (N=2411)

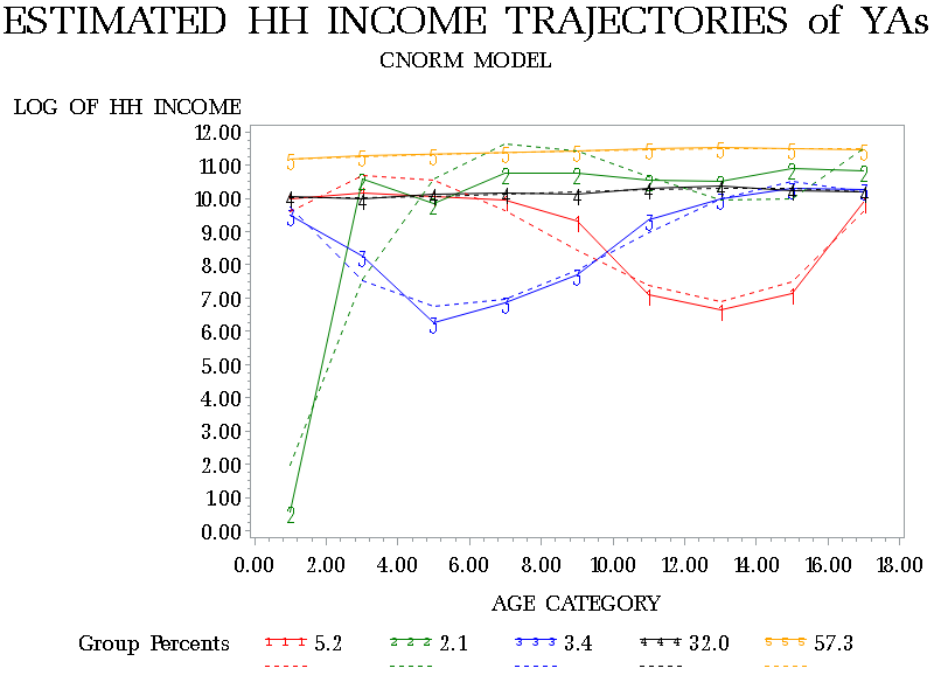
Group	Average group probability	Parameter Term	Estimate	Standard Error
1	0.93	Intercept	-5.530**	0.48
		Linear	3.298**	0.21
		Quadratic	-0.212**	0.02
		Cubic	0.004**	0.00
2	0.99	Intercept	9.217**	0.16
		Linear	0.115	0.10
		Quadratic	-0.059*	0.01
		Cubic	0.003**	0.00
3	0.93	Intercept	1.792**	0.15
		Linear	3.087**	0.09
		Quadratic	-0.316**	0.01
		Cubic	0.009**	0.00

4	0.87	Intercept	10.079**	0.06
		Linear	-0.046	0.03
		Quadratic	0.010 ˢ	0.00
		Cubic	-0.000 ˢ	0.00
5	0.93	Intercept	11.245**	0.04
		Linear	0.035*	0.01
		Quadratic	-0.000	0.00

***p<0.0001; *p=<0.01; ˢp=<0.05;* Sigma: 1.28745; SE: 0.00640; BIC=-38271.38 (N=2411)

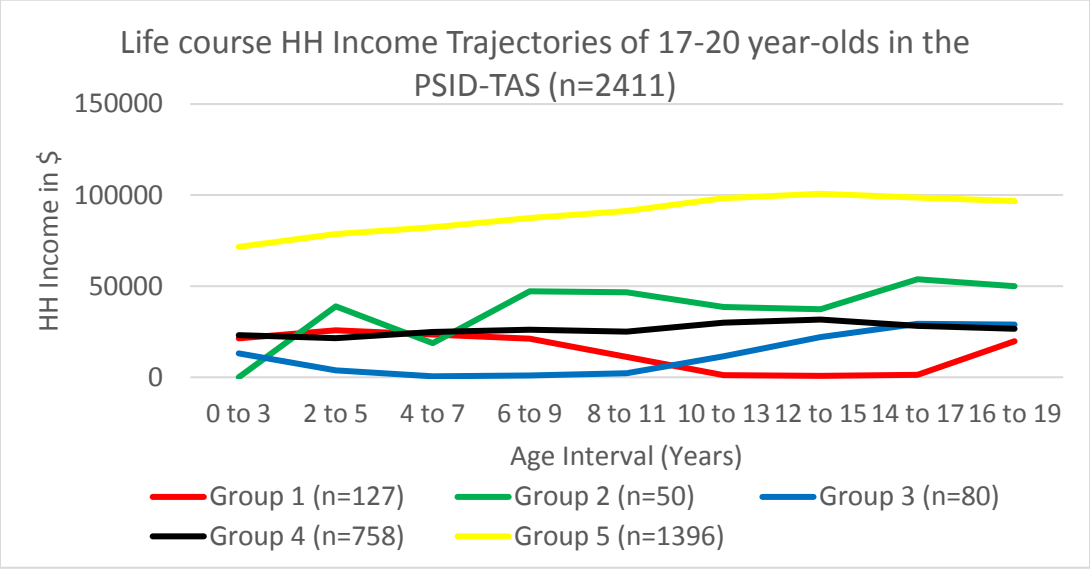
The log-transformed and real household income trajectories are presented in Figures 2a and 2b, respectively. Figure 2b illustrates that while five distinct groups emerged from the data, relative to the other life course income groups, four of the groups seem to cluster together in the low to middle income range (Groups 1-4). However, there is significant variation in the patterning/fluctuation between trajectories even in the lower to middle income range.

Figure 2a: Household Log-Transformed Income Trajectories of Young Adults



*Model predicting log-household income, adjusted for young adult age

Figure 2b: Life Course Household Income Trajectories of Young Adults, in 2014 dollars



The results of the group-based trajectory modeling procedure to estimate the 20-year income trend of matched grandparents are presented in Tables 2C-2D and Figures 2c-2d. Three distinct income groups emerged from the data, of roughly equal membership percentage (Table 2C). The average probability of correct group membership placement in the final 3-group model exceeded 95% for each income trajectory (Table 2D). See Appendix F for details on trajectory model fitting of grandparents.

Table 2C: Income Group Membership of Grandparents of Young Adult Sample Respondents (N=2014)

Group	Frequency	Membership %	Standard Error	95% CI
Group 1	406	20.16	1.068	18.06, 22.25
Group 2	851	42.25	1.191	39.91, 44.58
Group 3	757	37.59	1.191	35.25, 39.92

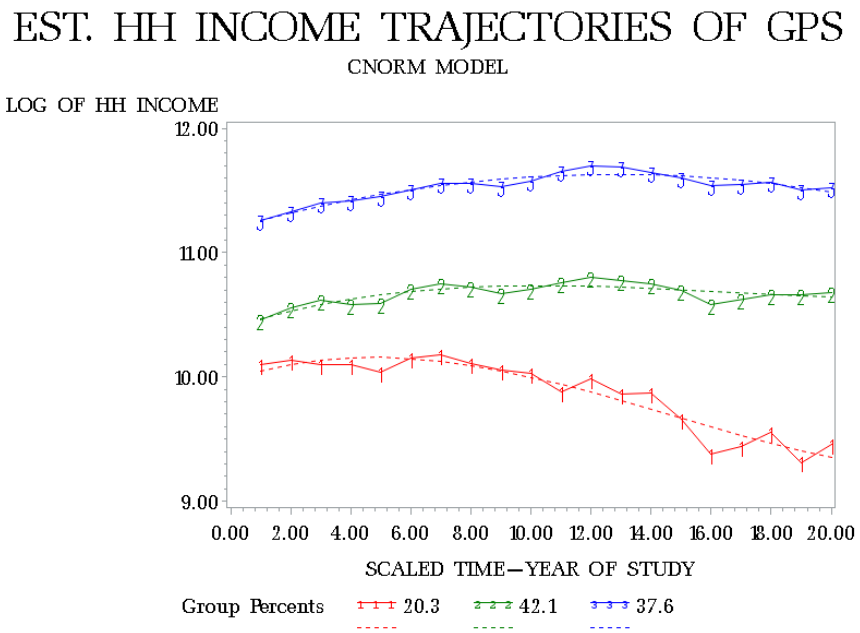
Table 2D: Parameter Estimates for 3-Group Log Income Trajectory Model for Grandparents

Group	Average group probability	Parameter Term	Estimate	Standard Error
1	0.97	Intercept	9.971**	0.03
		Linear	0.083**	0.01
		Quadratic	-0.010**	0.00
		Cubic	0.000**	0.00
2	0.96	Intercept	10.392**	0.02
		Linear	0.077**	0.01
		Quadratic	-0.005**	0.00
		Cubic	0.000*	0.00
3	0.98	Intercept	11.196**	0.02
		Linear	0.068**	0.00
		Quadratic	-0.002**	0.00

***p<0.0001; *p=<0.01; ˢp=<0.10;* Sigma: 0.66778; SE: 0.00237; BIC= -42820.58 (N=2014)

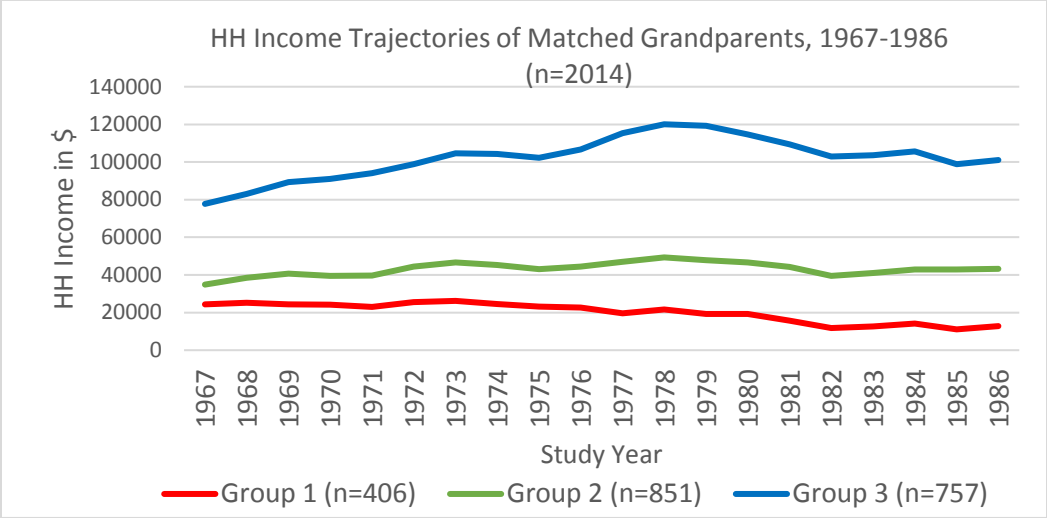
The log transformed and real 20-year income trends of grandparents are in Figures 2c-2d.

Figure 2c: Household Log-Transformed Income Trajectories of Grandparents Matched to Young Adult Sample Respondents (1967-1986)



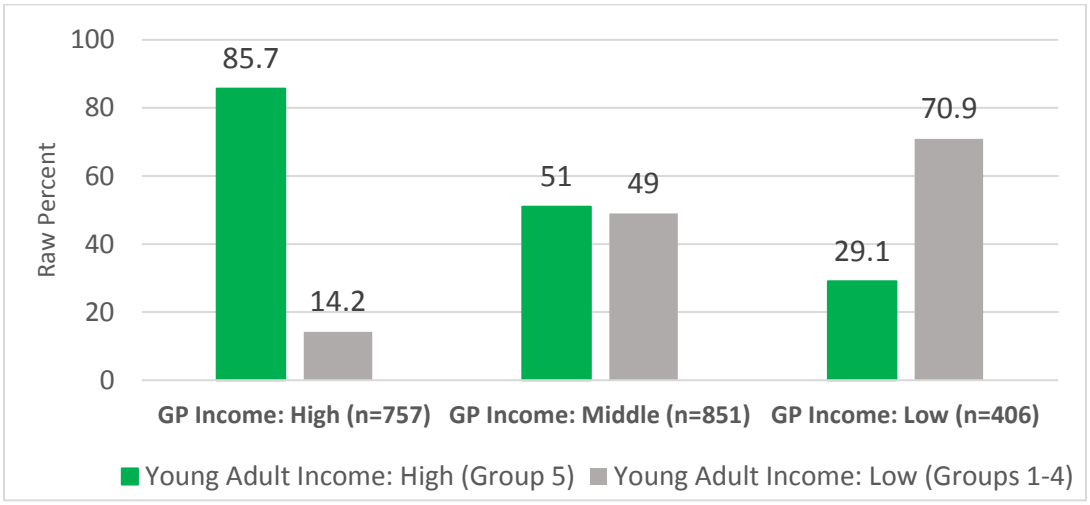
*Model predicting log-household income of GPs, adjusted for time/calendar year

Figure 2d: Household Income Trajectories of Grandparents in 2014 dollars, (1967-1986)



While not as much variation is apparent within the trajectories, the income levels are distinct enough to be labeled low (Group 1), middle range (Group 2) and high (Group 3).

Figure 3: Grandparent Household Income (1967-1986) and Young Adult Life Course Income (1987-1997)



p<0.0001

Young adult life course income trajectories were linked to grandparents' 20-year income trends as depicted in the chart above (Figure 3A). The five life course income trajectories of young adults were collapsed into 2 broad groups based on income level: high (Group 5) and low (Groups 1-4). As shown, among high income grandparents, nearly 86% of their grandchildren are also high income; whereas among low income grandparents, 71% of their grandchildren are also low income. Among middle income grandparents (GP, Group 2), there is a nearly even split of high or low- income grandchildren. While the monotonic transmission of socioeconomic status across generations is apparent from this chart, there is also some upwards social mobility between generations. In particular, a slightly greater proportion of grandchildren move up out of low-income into high income families (29%) than grandchildren who are raised in low income families if they have high income grandparents (14%).

The results from the grandparent-grandchild intergenerational income trajectory (IIT) composite variable are shown in Table 3. As is reflected in the figure, the majority of young adults are of a high-high IIT (32%), followed by middle-high (22%) and middle-low IIT (21%). Few were of low-high (6%) or high-low (5%) IIT, and 14% belonged to the low-low IIT group.

Table 3: Intergenerational Income Trajectory Summary Variable (N=2014 Young Adult and Grandparent Pairs)

Intergenerational Income Trajectory (IIT)	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Low-Low	288	14.30	288	14.30
Low-High	118	5.86	406	20.16
Middle-Low	417	20.71	823	40.86
Middle-High	434	21.55	1257	62.41
High-Low	108	5.36	1365	67.78
High-High	649	32.22	2014	100.00

The relative proportions of participants at low or higher distress levels by income and other covariates is presented in Table 4. A slightly higher proportion of Non-Hispanic Blacks or Hispanics reported moderate or severe distress compared to Non-Hispanic Whites (25%, 25% vs. 21%), and more females reported moderate/severe distress than males (25% vs 19%). Young adults in the lower and fluctuating income groups (Groups 2-4) reported slightly higher rates of distress (27%-28%) than those in either the lowest life course income group or the highest (~20%). 56% of those who reported being diagnosed with a psychiatric disorder reported moderate/severe distress.

Table 4: Individual and Family Level Characteristics and Psychological Distress among Young Adults (N=2411)

Characteristic % (SE)	None/Mild Distress Score N=1859; 77.7%	Moderate/Severe Distress Score N=552; 22.3%
Female	74.5 (1.51)	25.4 (1.51)
Male	80.8 (1.68)	19.1 (1.68)
Race: Non-Hispanic White	78.5 (1.91)	21.5 (1.91)
Non-Hispanic Black	74.9 (2.05)	25.1 (2.05)
Hispanic	75.5 (2.81)	24.5 (2.81)

Age: 17	80.3 (3.86)	19.7 (3.86)
18	77.2 (1.54)	22.7 (1.54)
19	75.8 (2.15)	24.1 (2.15)
20	81.6 (2.62)	18.4 (2.62)
Romantic Relationship[b]	77.5 (1.52)	22.5 (1.52)
No Relationship	77.8 (1.44)	22.1 (1.44)
Psychiatric Diagnosis Ever[b]	43.6 (3.62)	56.4 (3.62)
Study Year: 2005	79.8 (2.34)	20.2 (2.34)
2007	73.6 (2.96)	26.4 (2.96)
2009	80.3 (2.50)	19.7 (2.50)
2011	76.1 (2.57)	23.8 (2.57)
2013	75.7 (2.97)	24.3 (2.97)
2015	79.1 (3.00)	20.9 (3.00)
YA Lifecourse Income: 1. Low-Lower-Low	79.9 (5.19)	20.1 (5.19)
2. Middle Fluctuating	72.9 (7.94)	27.1 (7.94)
3. Very Low- Upward	73.3 (3.79)	26.7 (3.79)
Plateau	72.1 (3.07)	27.8 (3.07)
4. Low/Middle Steady	80.1 (1.59)	19.9 (1.59)
5. High		
GP Income Trend: 1. Low	80.5 (3.27)	19.4 (3.27)
2. Middle	75.1 (2.41)	24.9 (2.41)
3. High	80.5 (1.80)	19.4 (1.80)
Intergenerational Income Trajectory[1]: Low-Low	80.0 (3.78)	20.0 (3.78)
n=2014 Low-High	81.6 (6.81)	18.3 (6.81)
Middle-Low	68.8 (3.38)	31.2 (3.38)
Middle-High	79.8 (2.39)	20.2 (2.39)
High-Low	73.7 (6.03)	26.2 (6.03)
High-High	81.6 (1.93)	18.3 (1.93)
Parents' Highest Education[b]: <HS	74.6 (2.66)	25.4 (2.66)
HS Degree	75.5 (2.33)	24.4 (2.33)
Some College	78.4 (2.35)	21.5 (2.35)
College Degree	82.4 (2.87)	17.6 (2.87)
Post-graduate	78.2 (2.97)	21.8 (2.97)
Parent Marital Status[b]: Married	79.1 (1.28)	20.8 (1.28)
Never Married	77.1 (3.63)	22.9 (3.63)
Sep/Wid/Div	73.7 (2.58)	26.3 (2.58)
Parent Any Psych Diagnosis Ever[b]	71.7 (3.99)	28.3 (3.99)
Past-Year Family Income Quartile*[b]		
Quartile 1: 1-31,432	72.7 (2.96)	27.2 (2.96)
Quartile 2: 31,433-61,693	74.4 (2.55)	25.6 (2.55)
Quartile 3: 61,694-113,999	77.5 (2.39)	22.5 (2.39)
Quartile 4: 114,000 +	82.2 (1.55)	17.7 (1.55)

*Past year household income quartile and life course income trend may not be mutually exclusive

[b] Covariates measured at time of K6 score

[1]Trajectory group describes the trajectory from grandparent to (-) young adult life course income from birth to 17. Young adult life course income groups 1,2,3, and 4 were categorized as "low" and group 5 was categorized as "high"

Table 5A (below) outlines the results of the regression models predicting distress as a function of young adult life course household income trajectory group. Similar to the relative proportions in Table 4, those in the lower to middle fluctuating income groups (Groups 2-4) had increased prevalence of psychological distress when compared to those in the highest income group (Group 2 PR: 1.37; (95% CI: 0.73), 2.59, Group 3 PR: 1.32; (95% CI: 0.77, 2.27), Group 4 PR: 1.39; (95% CI: 1.02, 1.90)). These unadjusted estimates were only slightly attenuated when adjusted for all covariates, including parents' psychiatric diagnoses, marital status, and highest level of education (aPR: 1,32, 1.27 and 1.32, respectively); however, confidence intervals were wide due to small sample sizes for some of the groups. Young adults belonging to the lowest life course income group had slightly decreased prevalence of psychological distress when compared to the highest income group (aPR: 0.91; 95% CI: 0.51, 1.60) although estimates were not significant.

Table 5A: Association of Young Adult Life Course Income with Prevalence Psychological Distress

	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]
	PR (95% CI)[d]	PR (95% CI)	PR (95% CI)	PR (95% CI)
Income Group				
G1: Low, Lower, Low (20k, decrease, 20k)	1.02 (0.57, 1.82)	1.06 (0.62, 1.83)	0.87 (0.49, 1.54)	0.91 (0.51, 1.60)
G2: Middle fluctuating (10k to 40k to 20k to 40k, 55k)	1.37 (0.73, 2.59)	1.47 (0.77, 2.82)	1.44 (0.73, 2.82)	1.32 (0.64, 2.72)
G3: Very Low Upwards (1k to 20k @10-13 years old)	1.32 (0.77, 2.27)	1.26 (0.72, 2.21)	1.31 (0.75, 2.31)	1.27 (0.73, 2.20)
G4: Lower middle steady (20k to 30k across life course)	1.39 (1.02, 1.90)	1.38 (0.98, 1.95)	1.34 (0.94, 1.91)	1.32 (0.93, 1.87)
G5: High (80-100k across life course)	1.00	1.00	1.00	1.00

[a]Model 1 adjusted for young adult characteristics: survey year, race, sex, age category, relationship status

[b] Model 2 adjusted for parent characteristics: psychiatric diagnosis/ever (any parent), parent marital status

[c] Model 3 additionally adjusted for parents' highest level of education

[d] PR=prevalence ratio, 95% CI=confidence interval

Table 5B: Association of Grandparent - Young Adult Intergenerational Income Trajectory (IIT) and Psychological Distress

	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]
	PR (95% CI)[d]	PR (95% CI)	PR (95% CI)	PR (95% CI)
Trajectory Group[1]				
Low-Low (n=288)	1.05 (0.68, 1.60)	1.02 (0.61, 1.69)	0.95 (0.55, 1.64)	0.88 (0.47, 1.66)
Low-High (n=118)	0.97 (0.46, 2.05)	0.99 (0.44, 2.23)	0.94 (0.42, 2.12)	0.92 (0.40, 2.09)
Mid-Low (n=417)	1.68 (1.17, 2.43)	1.69 (1.08, 2.66)	1.58 (0.96, 2.60)	1.55 (0.93, 2.57)
Mid-High (n=434)	1.09 (0.79, 1.52)	1.14 (0.80, 1.61)	1.09 (0.76, 1.56)	1.07 (0.74, 1.55)
High-Low (n=108)	1.42 (0.84, 2.41)	1.49 (0.88, 2.54)	1.28 (0.74, 2.20)	1.27 (0.75, 2.13)
High-High (n=649)	1.00	1.00	1.00	1.00

[1]Trajectory group describes the GP-YA income trajectory (grandparent to young adult life course income from birth to 17). Young adult life course income groups 1,2,3, and 4 were categorized as "low" and group 5 was categorized as "high"

[a] Model 1 adjusted for young adult characteristics: survey year, race, sex, age category, relationship status

[b] Model 2 adjusted for parent characteristics: psychiatric diagnosis/ever (any parent), parent marital status

[c] Model 3 additionally adjusted for parents' highest level of education

[d] PR=prevalence ratio, 95% CI=confidence interval

The association between IIT category and psychological distress is presented in Table 5B above. Compared to young adults of high-high IIT, those of middle-low IIT were 68% more likely to have increased levels of psychological distress (PR: 1.68; 95% CI: 1.17, 2.43) and those of high-low IIT had nearly 1.5 times the risk of distress (PR: 1.42; 95% CI: 0.84, 2.41). These results were attenuated after adjustment for covariates (aPR: 1.55 and 1.27, respectively) but nonetheless remained elevated. However, those of low-low IIT and low-high IIT had decreased rates of psychological distress when compared to the high-high IIT category (aPR: 0.88; 95% CI: 0.47, 1.66; and aPR:0.92; 95% CI: 0.40, 2.09, respectively), although confidence intervals were wide.

A supplementary analysis examined both the total and direct association of grandparent 20-year income trend and young adult grandchild's psychological distress level (Table 5C), accounting for parental characteristics and young adult life course household income. While effect estimates in neither the adjusted nor unadjusted models was significant, young adults with middle income grandparents (income levels at ~$45,000yearly) were at slightly greater risk of elevated distress when compared to young adults with high income grandparents, even when adjusted for young adult's own life course income group during childhood (aPR: 1.10; 95% CI: 0.78, 1.56). Similar to the life course and IIT category analyses, grandparents at the lowest income trajectory (~$20,000 yearly) seemed to confer a protective effect on young adult psychological distress (aPR: 0.80; 95% CI: 0.47, 1.38). A post-hoc sensitivity analysis of young adult income and distress showed marginal, but not significant, improvement in model fit/prediction upon adjustment for grandparents' income trend (Appendix G)

Table 5C: Association of Grandparent Income Trend and Young Adult Psychological Distress

	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]
	PR (95% CI)[d]	PR (95% CI)	PR (95% CI)	PR (95% CI)
Trajectory Group				
GP Low (~20k)	0.96 (0.67, 1.38)	0.89 (0.57, 1.39)	0.79 (0.47, 1.34)	0.80 (0.47, 1.38)
GP Middle (40-50k)	1.27 (0.92, 1.75)	1.25 (0.89, 1.77)	1.19 (0.83, 1.70)	1.10 (0.78, 1.56)
GP High (90-120k+)	1.00	1.00	1.00	1.00

[a] Model 1 adjusted for young adult characteristics: survey year, race, sex, age category, relationship status

[b] Model 2 adjusted for parent characteristics: psychiatric diagnosis/ever (any parent), parent marital status, parent highest level education

[c] Model 3 additionally adjusted for young adult life-course income group

[d] PR=prevalence ratio, 95% CI=confidence interval

Discussion

Using prospective data spanning 40 years, this study found that downward fluctuations or shifts in household income over generations influence current young adult psychological distress to a greater degree than low but stable income trends. The middle to low intergenerational income trajectory category was associated with 1.5 times the prevalence of elevated distress in young adulthood compared to the high-high IIT group while membership in the low-low IIT category conferred a somewhat protective effect on psychological distress. Similarly, young adults in the high-low IIT were also more likely to experience psychological distress at age 18.

Our study was novel in that it is the first to link household income trajectories across generations to examine a 3rd generation mental health outcome. We extend prior research indicating that downward socioeconomic shifts between two generations were associated with worse mental health outcomes than consistently high socioeconomic standing (Ward J et al, 2016; Melchior M et al 2017). However, unlike these studies, we did not find worse psychological distress symptomology among families with chronic or sustained low SEP. On the contrary, while our results were marginally significant, stable but low household income trajectories were, at worst, similar in effect to high income trajectories on distress symptoms, in that group membership in the lowest income groups did not necessarily translate into added mental health risk.

Life course research beyond the effects of the nuclear family posits that higher socioeconomic benefits or disadvantages from earlier generations "build up" and are carried through the family lineage (Li M 2015; Chan TW and Boliver V; 2013, as cited in Li, 2015). Our results suggest that resource loss rather than built-up resource retainment

from earlier generations is the key driver of mental health outcomes in later generations. That is, families with more income fluctuations from high or middle to low may do worse in terms of distress than those who move from low to high or those in stable (low) income categories. That said, however, while both 'downward' trajectories were associated with increased distress, the risk associated with high-low trajectories was not as pronounced as that of the middle-low group; which nonetheless speaks to the protective effect of high income resource accumulation in earlier generations.

While the mechanism behind our findings is not immediately clear, our results may be influenced both by the young adult population in which psychological distress was examined as well as the income (as opposed to other SEP) measure used. A recent study of childhood wealth and young adult distress in the PSID (Le-Scherban F et al 2016) suggests that wealth, as opposed to income, may be "more sensitive to the broader economic context, age, job and health status." (Kiester and Moller, 2000 as cited in Le-Scherban F, et al 2016, pg 799). While this may be true, wealth estimates in this study were strongly attenuated upon adjustment for household income, thereby supporting our use of income as a critical determinant of health. Further, the Le-Scherban study used a summary measure of average wealth across the life course and did not capture resource fluctuations over life course stages as our income trajectories did.

Another explanation for our results may be in the timing of the psychological distress measurement relative to the timing of household income spikes or dips. Downward fluctuations occurring later in the life course and closer to psychiatric outcome ascertainment may have more of an impact on health than SEP insults occurring

earlier. This is particularly relevant given the adaptability and resilience of children to certain early life circumstances.

There are several limitations of our study which deserve mention. As long as it temporally preceded the young adult life course, grandparents' 20-year income trends could be measured at any time during their lifetimes, and income is sensitive to both time and individual age. Misclassification into lower income trends among retirees or those of older age is certainly a possibility, although this is unlikely given the consistency of intergenerational income transfer across generations. Grandparents' income trends also spanned a considerable time period, such that curves were likely to capture periods of employment or taxable income flow.

Similarly, because our young adult sample was a combined sample of 17 to 20-year-olds across 6 study waves and 10 years, there were periods of missing income assessments between young adult and grandparent's income trends. The period of grandparent income ascertainment (1967-1986) would only immediately precede the life course household income for an 18-year old in the 2005 study wave; for an adolescent of the same age in the 2015 data wave, 10 years of the grandparental income trend would be missing. Unmeasured income fluctuations could have certainly occurred within this interval; however, considering that 20 years of grandparent's income was available before this interval, income transitioning or retirement-based income fluctuation poses less of a problem.

The basis for collapsing grandchildren's 5-group trajectories into 2 groups for IIT creation was made on account of sample size considerations and model parsimony. As such, greater emphasis was put on absolute or averaged income level across the life

course than on individual trajectory fluctuations throughout the life course when creating the combined 2 group variable. The potential for residual confounding might affect estimates if trajectories with upwards or downwards income shifts suggestive of differential effects on distress were grouped with heterogeneous income trajectories and collectively labeled “low” because the average income level between the groups was similar.

The potential for reverse causality (social selection) bias in the association between income and mental health status is a possibility in this or any study of psychiatric epidemiology or in social epidemiology research more broadly. Furthermore, our distress models did not adjust for psychiatric diagnoses because timing the receipt of diagnosis relative to onset of psychological distress symptoms was complex in this sample. However, we attempted to mitigate this potential bias by adjusting models for the presence of parental-reported psychiatric diagnosis, which can both affect young adult life course income and be transmitted to children via genetic or sociobiological pathways. We also did not adjust models for other factors that contribute to adolescent distress, many of which are at the school, peer, or neighborhood level.

Despite these limitations, our study was important in that it is the first to granularly and prospectively define income mobility across generations and quantify the effect on young adult mental health status. It is also the first to utilize a time-varying and longitudinal measure of SEP rather than a time invariant or averaged measure such that important inflection points across the life course were effectively captured. The analyses employed allowed us to visualize the long-term economic context preceding mental health symptoms. We found that fluctuations in household income, particularly

downward shifts, pose greater risks to mental health than the cumulative effect of low income given a more stable financial context. Specifically, our results suggest that accumulated income disadvantages are not necessarily additive for all health outcomes or at all times. There may exist low income 'effect thresholds' which are dependent on the timing of their occurrence and the wider socioeconomic circumstance. Future research in this area should incorporate other measures of SEP into a longitudinal and long-range income framework to see how this might shape the effects of resource fluctuation on mental illness.

Paper 3:

Examining Subgroup Differences in the Income Trajectory and Psychological Distress Relationship

Introduction

Previous chapters of this doctoral dissertation have found that decreasing income trends and downward income trajectories are associated with an increased prevalence of psychological distress among middle aged and young adults. While both studies adjusted for risk factors and other covariates related to distress, income trends were assumed to have a homogeneous effect on distress across all sample demographic sub-groups. For example, race/ethnicity may predispose one to differential sources of psychological distress due to racial/ ethnic discrimination, and racial/ethnic subpopulations may occupy certain income trajectories disproportionately more than others. The combination of these distinct social exposures can heighten the overall risk for mental illness. For example, a previous study of neighborhood SEP, race and depression/anxiety found that African-Americans living in affluent neighborhoods were at greater risk for past-year depression compared to non-Latino Whites, as were Latinos living in neighborhoods of higher Latino-immigrant concentrations (Alegria M et al, 2014). Similarly, girls and women are more likely to experience depression than boys and men, and there is some evidence to suggest that socioeconomic factors may play a greater role in how depression develops among females (van Loo HM et al, 2017).

This study aimed to explore if the association between life course income trend and distress symptoms differs based on sex or racial/ethnic group. This paper expands upon our prior research by examining subgroup differences in Papers 1 and 2.

Methods

Statistical Analyses: This study expanded upon the results of the pooled income trajectories created in the prior papers. As such, the main statistical method was the addition of an income trajectory*race, or income trajectory*gender statistical interaction term in the log-binomial regression models predicting psychological distress. Interaction terms were added to models fully adjusted for all covariates, and the prevalence ratio associated with the income trajectory at each level of the interaction term was both reported and graphically depicted.

Descriptive statistics were presented as frequencies and unweighted percentages in tables showing income group/trajectory and psychological distress percentages by race/ethnicity or by gender. Bivariable tables were not tested for statistically significant differences or non-zero differential effects of the interaction variable across exposure and outcome levels. Rather, it was assumed that interaction may occur upon a mixing of effects between the exposure and extraneous factor (or interaction variable) regardless of the singular effect of income, race/ethnicity, or gender on distress. (Rothman K and Greenland S, 1998).

Results for Paper 1:

Lifetime Income Group and Psychological Distress by Race and Gender among Adults (aged 35-50)

Table 1 shows the relative proportions of the both the exposure (in this case, adult income trend group) and the outcome (moderate/severe psychological distress) at each level of race/ethnicity; whether Non-Hispanic White, Non-Hispanic Black, or Hispanic. 94 adult individuals who reported 'other' for race/ethnicity questions were omitted from these analyses.

Table 1: Income Group and Psychological Distress Percentages among Adults by Race/Ethnicity

	N (Col %)* 3185 (100)	**NH White** N=1920 (60.8)	**NH Black** N=1115 (35.3)	**Hispanic** N=123 (3.9)
Income	Group 1: Low	24 (1.2)	109 (9.8)	5 (4.1)
	Group 2: Low-mid increasing	184 (9.6)	438 (39.3)	22 (17.9)
	Group 3: Low-mid decreasing	31 (1.6)	73 (6.5)	0 (0)
	Group 4: Stable middle	906 (47.2)	417 (37.4)	54 (43.9)
	Group 5: High	775 (40.4)	78 (7.0)	42 (34.2)
K6 score: None/Low (0-7)		1706 (88.8)	957 (85.8)	110 (89.4)
Mod/Severe (8-24)		214 (11.2)	158 (14.2)	13 (10.6)
K6 Score: Severe mental illness (13-24)		66 (3.4)	49 (4.4)	2 (1.6)

*all percents are unweighted

Close to 40% of Blacks are part of the low to middle decreasing income trajectory, compared to 10% of Whites and 18% of Hispanics. About 10% of Blacks comprise the lowest income group compared to 4% of Hispanics and only 1% of Whites. Conversely, 40% of Whites are members of the highest income trajectory, compared to 34% of Hispanics and only 7% of Blacks. Among Blacks, 14% reported moderate/severe psychological distress compared to 11% of Whites and Hispanics.

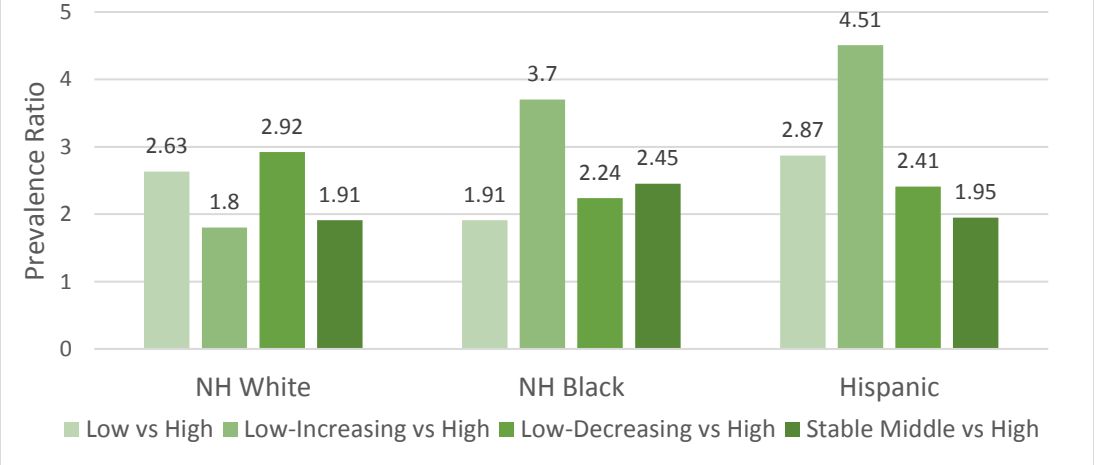
Prevalence ratios for each income trajectory group relative to the highest income group at each level of race/ethnicity are presented in Table 2 and depicted graphically in Figure 1.

Table 2: Association of Income Group with Distress among Adults by Race/Ethnicity*

	NH White (N=1920)	**NH Black** (N=1115)	**Hispanic** (N=123)
	PR (95% CI)	PR (95% CI)	PR (95% CI)
Income Group			
Group 1: Low	2.63 (1.10, 6.27)	1.91 (0.35, 10.33)	2.87 (0.04, 201.62)
Group 2: Low-middle increasing	1.80 (0.94, 3.43)	3.70 (0.75, 18.36)	4.51 (0.53, 38.53)
Group 3: Low-middle decreasing	2.92 (1.31, 6.54)	2.24 (0.50, 9.92)	2.41 (0.53, 38.53)
Group 4: Stable Middle	1.91 (1.27, 2.88)	2.45 (0.53, 11.39)	1.95 (0.14, 27.63)
Group 5: High	1.00	1.00	1.00

*Models adjusted for age, race, sex, marital status, occupation of head, educational level, and (any) psychiatric diagnosis (ever).

Figure 1: Association of Income Group with Distress among Adults by Race/Ethnicity*



p=0.0704

All racial/ethnic groups had elevated levels of psychological distress at all lower income categories when compared to the highest income group, however, confidence intervals were exceedingly wide for the Hispanic subgroup due to small sample size. Our Aim 1 study results found that the prevalence of distress was highest among the low to middle decreasing income trajectory group. Although 40% of Blacks comprised the low-middle decreasing income trajectory, the risk of distress among Blacks (and Hispanics) was greatest in the lower to middle *increasing* income groups (Black aPR: 3.70; 95% CI: 0.75, 18.36; Hispanic aPR: 4.51; 95% CI: 0.53, 38.53). In other words, Blacks in the low to middle increasing income group had nearly four times the prevalence of psychological distress compared to Blacks in the highest income group, and Hispanics in this group had four and a half times the distress risk as Hispanics in the highest income group. On the other hand, Whites in the low to middle increasing income group had only 1.8 times the risk of distress compared to high income Whites.

Interestingly, Blacks in the lowest income trajectory had the lowest rates of elevated distress relative to the high-income group when compared to Whites and Hispanics (Black aPR: 1.91 vs. White aPR: 2.63 and Hispanic aPR: 2.87). The p-value for the income*race interaction term was marginally significant (p=0.0704).

Table 3 shows relative proportions of the income trajectory group membership and psychological distress among females and males.

Table 3: Income Group and Distress Percentages among Adults by Gender

		N (Col %) 3252 (100)	**Females** N=1744 (53.6)	**Males** N=1508 (46.4)
Income	Group 1: Low		93 (5.3)	50 (3.3)
	Group 2: Low increasing		382 (21.9)	284 (18.8)
	Group 3: Low decreasing		63 (3.6)	47 (3.1)

Group 4: Stable middle Group 5: High	739 (42.4) 467 (26.8)	675 (44.7) 452 (30.0)
K6 score: None/Low (0-7) Mod/Severe (8-24)	1523 (87.3) 221 (12.7)	1333 (88.4) 175 (11.6)
K6 Score: Severe mental illness (13-24)	70 (4.0)	49 (3.2)

Females have slightly only more psychological distress compared to males (13% vs. 12%), but more females are in the three lowest income/fluctuating trajectories than males. Slightly more males than females comprise the stable middle and highest income groups.

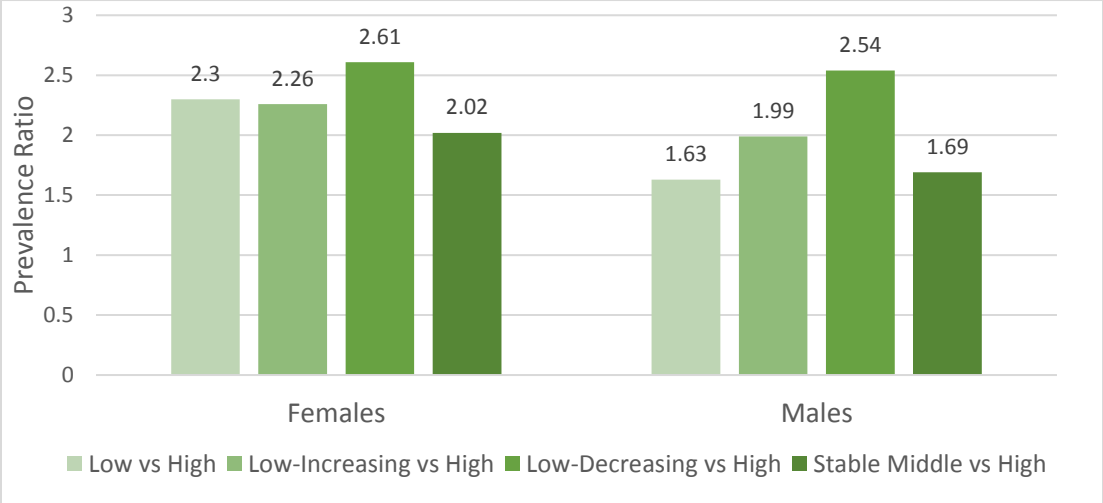
Prevalence ratios for each income trajectory group (relative to the highest income group) for males and females are presented in Table 4 and depicted graphically in Figure 2.

Table 4: Association of Income Group with Distress among Adults by Gender*

	Female (N=1744)	**Male** (N=1508)
	PR (95% CI)	PR (95% CI)
Income Group		
Group 1: Low	2.30 (1.05, 5.04)	1.63 (0.78, 3.39)
Group 2: Low increasing	2.26 (1.10, 4.65)	1.99 (1.13, 3.49)
Group 3: Low decreasing	2.61 (1.25, 5.45)	2.54 (0.97, 6.67)
Group 4: Stable Middle	2.02 (1.29, 3.17)	1.69 (1.06, 2.69)
Group 5: High	1.00	1.00

*Models adjusted for age, race, sex, marital status, current occupation of head, educational level, and any psychiatric diagnoses (ever)

Figure 2: Association of Income Group with Distress among Adults by Gender



p=0.8699

The results of this analysis show increased psychological distress among all lower income groups relative to the high-income group; this is the case for both males and females. However, females appear to be at higher risk of psychological distress regardless of income trajectory group compared to males; prevalence ratios range from 2.02 to 2.61 among women compared to 1.63 to 2.54 among men. It is important to note the p-value for the income*gender interaction term was not significant in this case; *p*=0.8699.

Results for Paper 2:

Life course Income Group and Psychological Distress by Race and Gender, among Young Adults (aged 17-20)

The life course income analysis results for Paper 2 of this project found that young adults in the lower to lower-middle life course income groups (Groups 2-4) had higher rates of distress compared to the highest (Group 5) or lowest (Group 1) income groups. For the purposes of this study, we collapsed young adult life course income trajectory Groups 1-4

into “low” income and Group 5 as “high” income in order to limit the number of strata of the interaction term and increase power.

Table 5 presents the relative proportions of young adult life course income group and psychological distress by racial/ethnic group.

Table 5: Income Group and Psychological Distress Percentages among Young Adults by Race/Ethnicity

	N (Col %) 2355 (100)	**NH White** N=1151 (48.9)	**NH Black** N=1009 (42.8)	**Hispanic** N=195 (8.3)
Lifecourse Group 1: Low-Lower-Low		38 (3.3)	75 (7.4)	12 (6.1)
Group 2: Middle Fluctuating		5 (0.4)	9 (0.9)	24 (12.3)
Group 3: V. Low Upward Plateau		12 (1.0)	58 (5.7)	7 (3.6)
Group 4: Low Steady		192 (16.7)	489 (48.5)	69 (35.4)
Group 5: High		904 (78.5)	378 (37.5)	83 (42.5)
Lifecourse Income Group: Low		247 (21.5)	631 (62.5)	112 (57.4)
High		904 (78.5)	378 (37.5)	83 (42.5)
K6 score: None/Low (0-7)		910 (79.1)	752 (74.5)	149 (76.4)
Mod/Severe (8-24)		241 (20.9)	257 (25.5)	46 (23.6)
K6 Score: Severe mental illness (13-24)		55 (4.8)	65 (6.4)	7 (3.6)
Intergenerational Income Trajectory				
N=1983	Low-Low	37 (3.6)	234 (27.3)	13 (12.7)
	Low-High	33 (3.2)	79 (9.2)	3 (2.9)
	Middle-Low	108 (10.5)	277 (32.3)	30 (29.4)
	Middle-High	217 (21.2)	188 (21.9)	22 (21.6)
	High-Low	75 (7.3)	26 (3.0)	6 (5.9)
	High-High	554 (54.1)	53 (6.2)	28 (27.4)

Approximately 63% of Black young adults were in the low life course income category, compared to 57% of Hispanics and 22% of Whites. The proportion of moderate/severe psychological distress was also slightly higher among Blacks than Whites or Hispanics (26% vs 21% and 23.6%).

Prevalence ratios for the low life course income trajectory category (relative to the high category) for Blacks, Whites, and Hispanics are presented in Table 6 and depicted graphically in Figure 3.

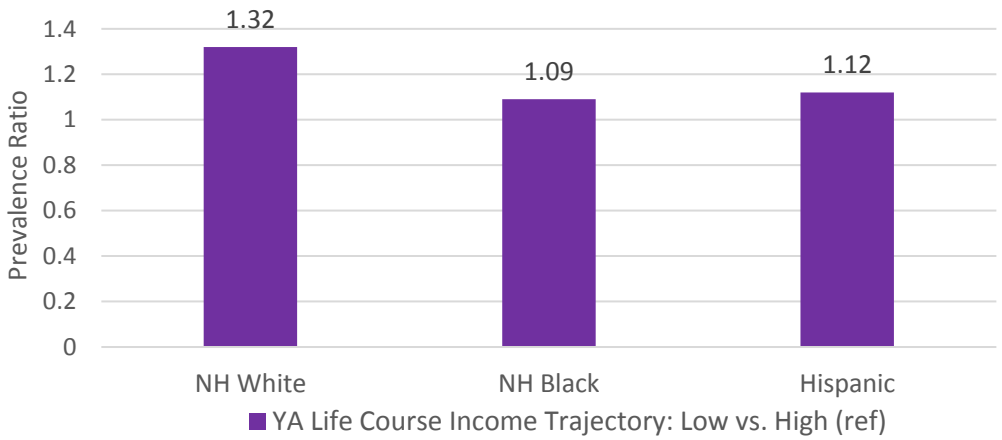
Table 6: Association of Life Course Income with Distress among Young Adults by Race/Ethnicity*

	NH White (N=1151)	**NH Black** (N=1009)	**Hispanic** (N=195)
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Life Course Income Trajectory Category			
Groups 1-4: Low	1.32 (0.93, 1.89)	1.09 (0.64, 1.87)	1.12 (0.63, 2.00)
Group 5: High	1.00	1.00	1.00

*Models adjusted for age, race, sex, relationship status, parent marital status, highest level of education, (any) psychiatric diagnoses (ever) and survey year

The results show that White young adults in the low life course income trajectory group have 1.32 times the prevalence of distress relative to high income White youth. Hispanic youth in the low life course income trajectory category have 1.13 times the distress risk, and Black youth have only slightly more than equal distress risk relative to the high-income group (aPR: 1.09; 95% CI: 0.64, 1.87). Confidence intervals among for Black and Hispanic estimates are wide, and the p-value for the life course income*race term was also not significant (p=0.7238).

Figure 3: Association of Life Course Income with Distress among Young Adults by Race/Ethnicity



p=0.7238

Lastly, we present the descriptive proportions and prevalence ratios by gender (Table 7). There are no real differences between male and female young adults by life course income group or category. Girls do however, have slightly higher rates of moderate/severe psychological distress compared to boys (26% vs. 20%).

Table 7: Income Group and Psychological Distress Percentages among Young Adults by Gender

	N (Col %)	**Female**	**Male**
	2411 (100)	N= 1240 (51.4)	N= 1171 (48.6)
Lifecourse Group 1: Low-Lower-Low		64 (5.1)	63 (5.4)
Group 2: Middle Fluctuating		28 (2.3)	22 (1.9)
Group 3: V. Low Upward Plateau		45 (3.6)	35 (3.0)
Group 4: Low/Middle Steady		393 (31.7)	365 (31.2)
Group 5: High		710 (57.3)	686 (58.6)
Lifecourse Income Group: Low		530 (42.7)	485 (41.4)
High		710 (57.3)	686 (58.6)
K6 score: None/Low (0-7)		924 (74.5)	935 (79.8)
Mod/Severe (8-24)		316 (25.5)	236 (20.1)
K6 Score: Severe mental illness (13-24)		81 (6.5)	49 (4.2)
Intergenerational Income Trajectory			
N=2014	Low-Low	159 (15.4)	129 (13.1)
	Low-High	59 (5.7)	59 (6.0)
	Middle-Low	217 (21.1)	200 (20.3)
	Middle-High	201 (19.5)	233 (23.7)
	High-Low	48 (4.6)	60 (6.10)
	High-High	346 (33.6)	303 (30.8)

Prevalence ratios for the low life course income trajectory category (relative to the high category) for girls and boys are presented in Table 8 and depicted graphically in Figure 4.

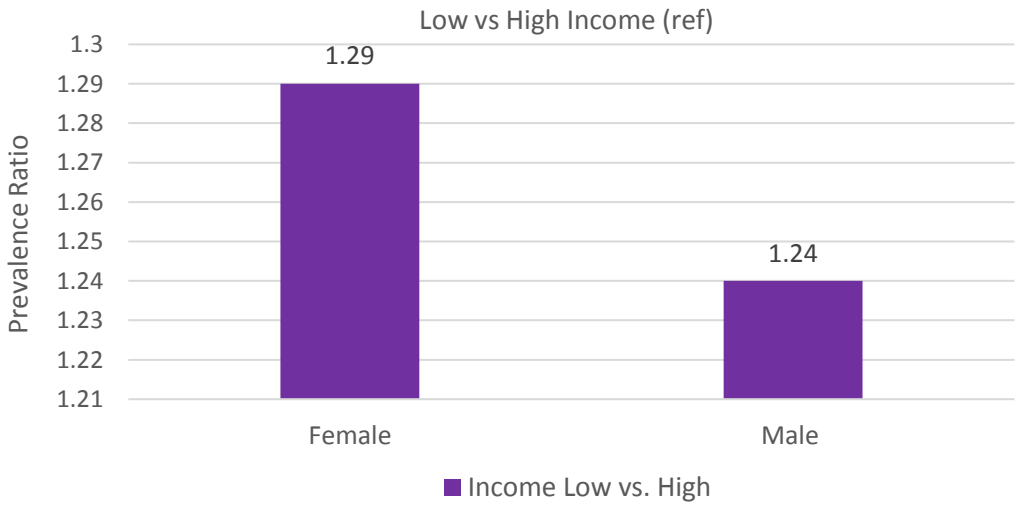
Table 8: Association of Life Course Income Category with Distress among Young Adults by Gender*

	Female	Male
	PR (95% CI)	PR (95% CI)
Life Course Income Trajectory		
Groups 1-4: Low	1.29 (0.90, 1.85)	1.24 (0.84, 1.84)
Group 5: High	1.00	1.00

*Models adjusted for age, race, sex, relationship status, parent marital status, highest level of education, (any) psychiatric diagnoses (ever) and survey year

Girls in the low life course income category have 1.29 times the prevalence of psychological distress compared to girls of high income (aPR: 1.29; 95% CI: 0.90, 1.85), this rate is only slightly more than that of boys in the low life course income category (aPR: 1.24; 95% CI: 0.84, 1.84). The p-value for the life course income*gender interaction term was also not statistically significant: p=0.7646.

Figure 4: Association of Life Course Income Category with Distress among Young Adults by Gender



p=0.7646

Discussion

While none of the interactive effects were statistically significant, our results show that there is at least marginal evidence for a differential risk of distress by income group and race/ethnicity. We found that the largest proportion of Black adults were part of the low decreasing income trajectory relative to Whites/Hispanics; however, distress was highest among Blacks and Hispanics in the low but *increasing* income trajectory group. On the other hand, membership in the lowest income trajectory relative to highest income trajectory seemed to affect Whites and Hispanics proportionately more than it did Blacks in terms of risk of mental health problems (White aPR:2.63; Hispanic aPR:2.87 vs. Black aPR: 1.91). Our gender-specific results, while not statistically significant, found that women and girls were more likely to experience elevated distress levels at all lower income groups relative to the high-income referent group when compared to men or boys.

Our findings support a large body of evidence indicating that SEP and income are unrelated to rates of depression among African-Americans (Hudson DL et al, 2012; pg 373.) A more recently published study by Assari (2017) on the social determinants of major depression found similar but more specific results using race by gender specific models. High income was found to be protective for White women, education was protective for African-American women, and high income was a risk factor for major depressive episode among African American men after controlling for other SES indicators. (Assari, S, 2017). These results reflect our findings in that non-Hispanic Black membership in the lower-middle increasing, or 'socially mobile' income trajectory increased the risk of psychological distress symptoms by nearly four-fold (aPR: 3.70) compared to the high-income group, despite the fact that the largest percentage of non-

Hispanic Blacks comprised the lower/ decreasing income trend. Our sex-specific results also found that distress among women was higher at each income group than it was for men, suggesting that women are possibly more sensitive to low income fluctuations or disadvantaged economic circumstances than men.

Another interesting finding from our analyses was that the low but increasing income group, or 'socially mobile' Hispanics had 4.5 times the risk of distress compared to high-income Hispanics, whilst the risk of distress among the lowest income group was similar to White rates; however, our relative sample size was small. While some studies have found similar rates of depression and other psychiatric disorders between US Hispanic and non-Hispanic populations (Kessler R as cited in Lewis-Fernandez 2005, pg 283), other research has consistently found that US-born or more acculturated Hispanics are at higher risk of depression than their foreign-born counterparts. (Lewis-Hernandez et al 2005; Ortega et al 2000; Escobar JI et al 2000). Socioeconomic factors such as income likely contribute heavily to this relationship; with researchers positing that lower rates of depression among foreign-born Hispanics may be due to a "lower set of expectations" in terms of what constitutes financial or social success than the US-born. (Vega and Kolody et al 1998 as cited in Escobar, JI et al 2000, pg 70).

Our Hispanic sub-sample seems to occupy a 'middle ground' between non-Hispanic Whites and non-Hispanic Blacks in terms of their risk of psychological distress given income group membership; their rates of distress given lowest income group or stable middle-income group relative to high income are similar to Whites, whereas membership in the socially mobile low-income group increases their risk of psychological distress to nearly twice that of socially mobile Blacks. This same

phenomenon is reflected in our intergenerational study, in that White young adults in the low life course income category had the highest risk of distress, followed by Hispanics, and then Blacks, compared to their high life course income counterparts.

Our analyses were mainly limited by the small sample size of Hispanics, causing instability in effect estimates. Due to the multigenerational design of our studies and the genealogical design of the PSID, all Hispanic individuals in our studies were descendants of or otherwise descended from original PSID sample families in 1968. Hispanics were added in much greater number to represent current population demographics in 1997 as part of the immigrant refresher sample, but these added families would not have 35-year income trends or grandparent household income captured in the PSID. The potential for life course and intergenerational research for racial/ethnic subgroups including Hispanics will likely increase as more waves of the PSID become available.

The race and gender specific results of this paper are notable for adding an important demographic dimension to the current SEP and mental health literature. Future analytic directions should consider stratifying income trajectory models by race to examine whether and how the overall shape and patterning of life course income differs by population demographics.

CONCLUSION

This project has added to the life course mental health literature by examining the role of income over the individual life course and across multiple generations. An overall theme in our findings has been the elevated prevalence of psychological distress in lower and decreasing or fluctuating income trajectories, both in young and middle adulthood; as such, we were unable to reject the a priori hypotheses made in the initial aims of this study. Similar results held at the intergenerational level between grandparents and grandchild life course income, in that those of the middle-low IIT category had the highest prevalence of psychological distress symptoms. Although few young adults were part of the high-low intergenerational category, this group also showed an elevated prevalence of distress symptoms but not at the level of the middle-low group-which perhaps indicates that resource accumulation in earlier high-income generations confers somewhat greater protection for the health status of low-income offspring.

Interestingly, we did not find that chronically low-income participants had any increase in psychological distress compared to high income individuals, either in life course or intergenerational models. Unless we conclude that there is no adverse mental health effect as a result of accumulated economic disadvantages, our race-specific findings suggest that the inherent adverse effects of cumulative low income may be felt more acutely for certain racial/ethnic subgroups over others.

Alternative explanations for our results should be considered. A common critique can emphasize the fairly proximal timing of income decreases in reference to psychological distress ascertainment. Many previous studies have acknowledged that childhood or early SEP is mediated by adulthood or later SEP when examining adult health outcomes

(Nandi A et al, 2012; Cerda M, et al 2011; Torres and Wong, 2013; Luo and Waite, 2005). Therefore, it is not surprising that we found an association between the highest distress levels and income trajectories that decreased in the latter part of measurement; and post-hoc analyses could not establish any real direct effect of the earlier income trend. Given that our focus was on cumulative exposure and social mobility models, we did not use any formal methods to test for mediation in our models, so it is unclear if this is an accurate interpretation for our results.

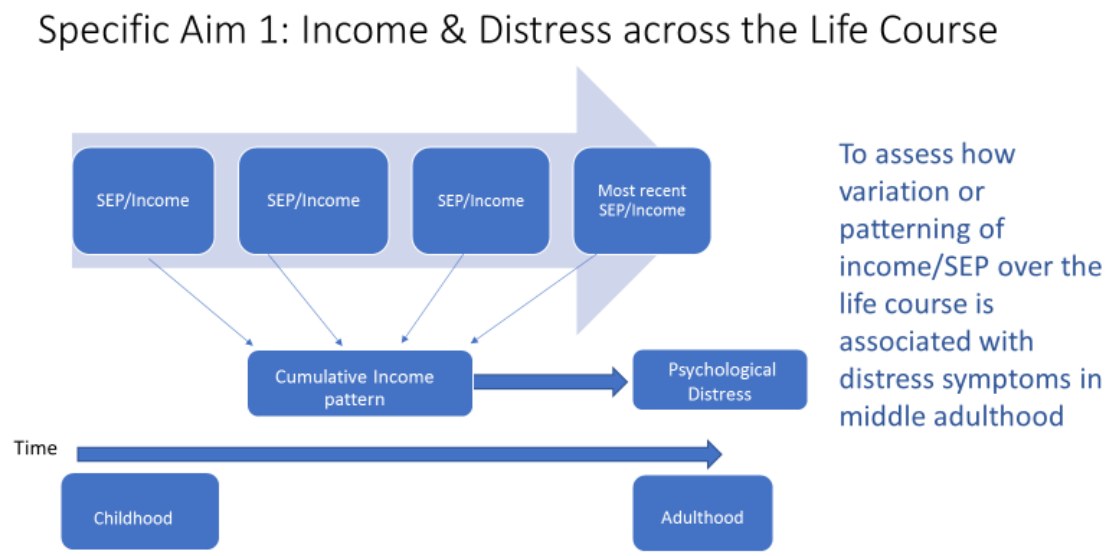
Recent research has argued in favor of measuring total vs. direct effects when estimating the true impact of life course models on health states (Green MJ and Popham F, 2017). With reference to accumulation studies, the issue is that solely measuring the direct effects of the income trend or intergenerational income trajectory on distress misses the total effect, or indirect effects of mediation by the most proximal income points. Cumulative exposure studies may also assume that the effect of each exposure is of equal magnitude on the outcome (Green MJ and Popham F, 2017). By measuring the uncontrolled total effect of long-term income trajectories on current distress and not including potential mediators or more recent income proxies in our core models, we likely limited our ability to accurately partition direct and indirect effects of the prior income trend when conditioned on more recent income proxies. (Cholero, et al 2014; Vanderweele 2010; as applied by Manderski M 2014). The use of longitudinal income patterning in our studies, however, allowed us to qualitatively interpret income fluctuations within the larger economic context in which they occurred. This contextual backdrop would not be taken into account with mediation models or alternate (perhaps more stable) measures of SEP.

The global limitations of our study should also be considered to aid interpretation of these results. Outcome measurement using the K-6 is not specific to any psychiatric diagnosis, although the K-6 question panel comes closest to the DSM-V depression diagnosis. It is not clear whether the K-6 is specific enough to differentiate between depression (a mood disorder) and schizophrenia, or even mild depression versus major depressive disorder (MDD). These are not trivial points, as more severe forms of depression or mental illness do in fact influence the ability to work, opportunities for status attainment, and improvements in SEP over time as the social selection hypothesis suggests. Although efforts were made to mitigate reverse causality bias in our analyses, results should be interpreted cautiously in light of these points. Outcome ascertainment also occurred at singular cross-sections of time, and as such, assumed the effects of life course income trajectories on psychological distress were immediately measurable. How life course income trajectories affect the shape of subsequent distress trajectories will be an interesting question for the author to explore as more data waves and K6 assessments in the PSID Transition to Adulthood supplement and Main Interview become available.

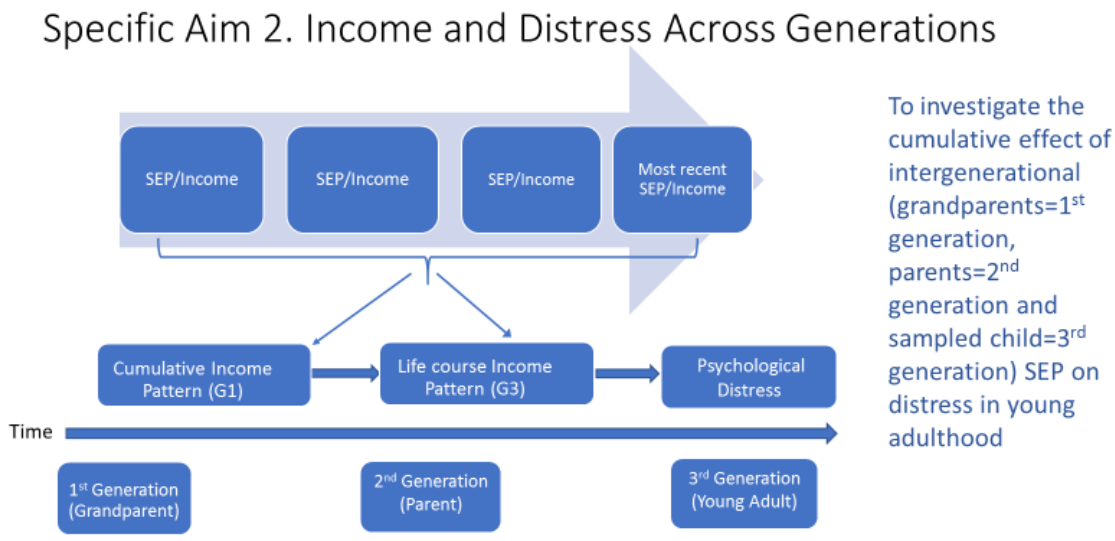
Despite these limitations, the findings from the present dissertation research provide compelling evidence on the role of income, i.e., socioeconomic position, and its association with psychologic distress. Elucidating how economic disadvantage operates in populations over time can aid researchers and public health professionals in the creation of programs and policies that properly identify those at risk; and in developing targeted and evaluable solutions at the individual, family, or community levels.

APPENDICES

Appendix A: Figure 1a.



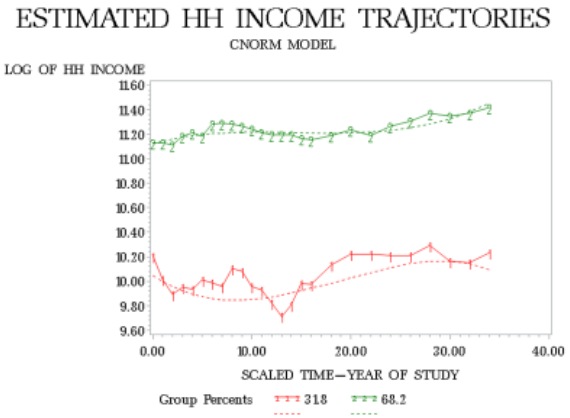
Appendix A: Figure 1b.



Appendix B: Graphs A-I and Table J: Trajectory Model Fitting Process for Adults

Graph A: 2 Group Model

2 GROUP MODEL



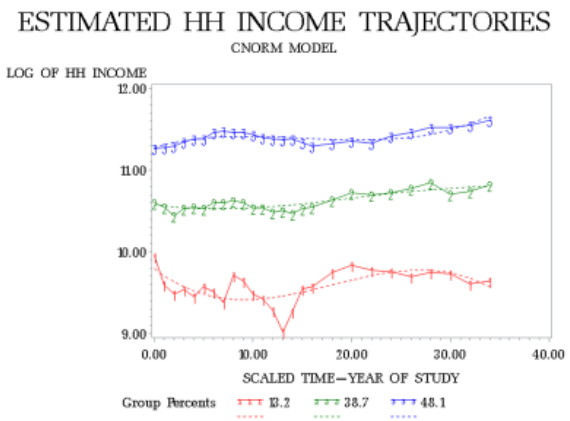
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.11162	0.02107	479.955	0.0000
	Linear	-0.05189	0.00550	-9.428	0.0000
	Quadratic	0.00399	0.00040	10.060	0.0000
	Cubic	-0.00007	0.00001	-9.020	0.0000
2	Intercept	11.13436	0.01385	804.073	0.0000
	Linear	0.02012	0.00364	5.527	0.0000
	Quadratic	-0.00148	0.00026	-5.638	0.0000
	Cubic	0.00003	0.00001	6.592	0.0000
	Sigma	1.00093	0.00247	405.727	0.0000
	Group membership				
1	(%)	31.63177	0.91597	34.533	0.0000
2	(%)	68.36823	0.91597	74.640	0.0000

BIC=-119589.8 (N=82859) BIC=-119573.6 (N=3252) AIC=-119543.2 L=-119533.2

Graph B: 3 Group Model

3 GROUP MODEL

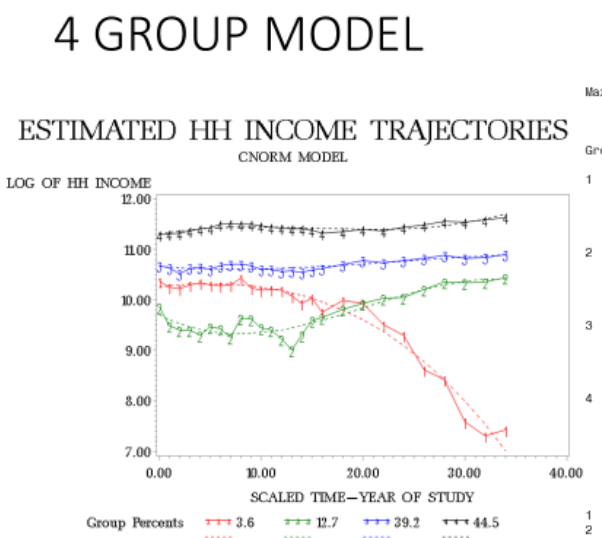


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.79430	0.03274	299.181	0.0000
	Linear	-0.09423	0.00891	-10.581	0.0000
	Quadratic	0.00691	0.00063	11.043	0.0000
	Cubic	-0.00013	0.00001	-10.272	0.0000
2	Intercept	10.57754	0.02713	389.829	0.0000
	Linear	-0.01687	0.00513	-3.289	0.0010
	Quadratic	0.00153	0.00038	4.012	0.0001
	Cubic	-0.00002	0.00001	-3.255	0.0011
3	Intercept	11.27886	0.01712	658.634	0.0000
	Linear	0.03311	0.00430	7.692	0.0000
	Quadratic	-0.00256	0.00031	-8.230	0.0000
	Cubic	0.00006	0.00001	9.152	0.0000
	Sigma	0.96112	0.00238	403.489	0.0000
	Group membership				
1	(%)	13.22305	0.84721	15.608	0.0000
2	(%)	38.66741	1.03737	37.275	0.0000
3	(%)	48.10953	1.31343	36.629	0.0000

BIC=-117208.3 (N=82859) BIC=-117184.0 (N=3252) AIC=-117138.4 L=-117123.4

Graph C: 4 Group Model

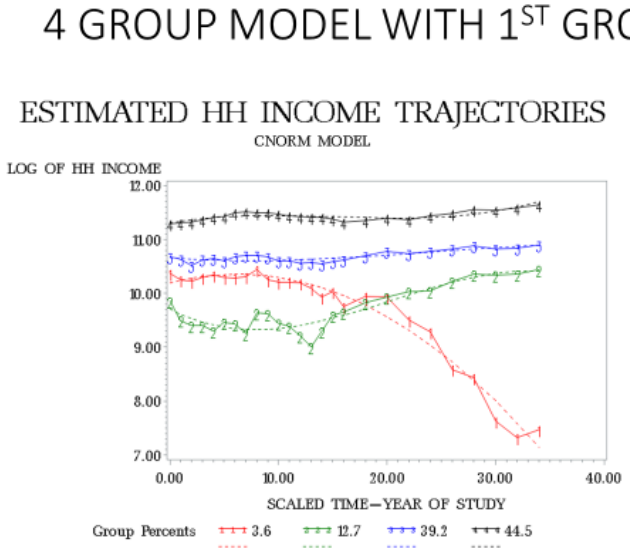


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.25801	0.06322	162.264	0.0000
	Linear	0.02116	0.01610	1.315	0.1885
	Quadratic	-0.00162	0.00118	-1.373	0.1699
	Cubic	-0.00005	0.00002	-2.181	0.0292
2	Intercept	9.70401	0.03291	294.877	0.0000
	Linear	-0.10365	0.00875	-11.840	0.0000
	Quadratic	0.00819	0.00063	12.998	0.0000
	Cubic	-0.00013	0.00001	-10.774	0.0000
3	Intercept	10.66182	0.02082	512.060	0.0000
	Linear	-0.01574	0.00490	-3.213	0.0013
	Quadratic	0.00124	0.00035	3.512	0.0004
	Cubic	-0.00002	0.00001	-2.434	0.0149
4	Intercept	11.30292	0.01732	652.738	0.0000
	Linear	0.03532	0.00439	8.052	0.0000
	Quadratic	-0.00272	0.00032	-8.581	0.0000
	Cubic	0.00006	0.00001	9.468	0.0000
	Sigma	0.93791	0.00232	403.902	0.0000
	Group membership				
1	(%)	3.55271	0.35771	9.932	0.0000
2	(%)	12.69712	0.67526	18.803	0.0000
3	(%)	39.23962	1.07249	36.588	0.0000
4	(%)	44.51056	1.20218	37.025	0.0000

BIC=-115573.8 (N=82859) BIC=-115541.4 (N=3252) AIC=-115480.5 L=-115460.5

Graph D: 4 Group Model with 1st Group Quadratic

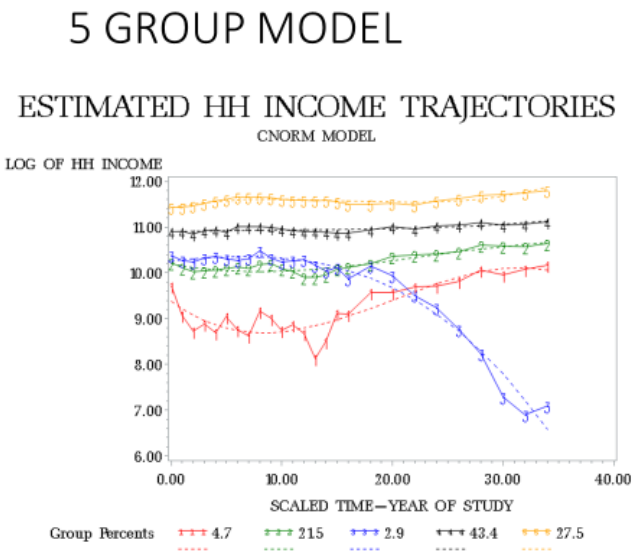


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.18741	0.05955	171.087	0.0000
	Linear	0.05222	0.00837	6.236	0.0000
	Quadratic	-0.00416	0.00026	-15.848	0.0000
2	Intercept	9.70618	0.03387	286.571	0.0000
	Linear	-0.10501	0.00883	-11.887	0.0000
	Quadratic	0.00831	0.00063	13.185	0.0000
	Cubic	-0.00014	0.00001	-10.998	0.0000
3	Intercept	10.66209	0.02090	510.100	0.0000
	Linear	-0.01586	0.00491	-3.234	0.0012
	Quadratic	0.00126	0.00035	3.553	0.0004
	Cubic	-0.00002	0.00001	-2.483	0.0130
4	Intercept	11.30330	0.01732	652.492	0.0000
	Linear	0.03536	0.00439	8.058	0.0000
	Quadratic	-0.00272	0.00032	-8.591	0.0000
	Cubic	0.00006	0.00001	9.477	0.0000
	Sigma	0.93790	0.00232	404.000	0.0000
	Group membership				
1	(%)	3.60569	0.35571	10.137	0.0000
2	(%)	12.67575	0.67362	18.817	0.0000
3	(%)	39.24863	1.07351	36.561	0.0000
4	(%)	44.46994	1.20376	36.943	0.0000

BIC=-115570.6 (N=82859) BIC=-115539.8 (N=3252) AIC=-115482.0 L=-115463.0

Graph E: 5 Group Model

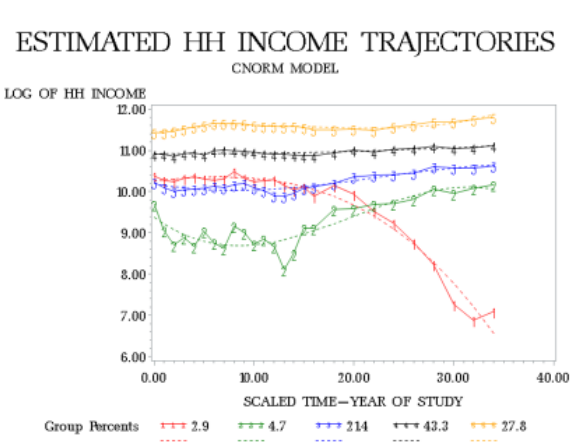


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.38189	0.05889	159.322	0.0000
	Linear	-0.18048	0.01387	-13.009	0.0000
	Quadratic	0.01364	0.00102	13.370	0.0000
	Cubic	-0.00023	0.00002	-11.125	0.0000
2	Intercept	10.19789	0.02734	373.011	0.0000
	Linear	-0.04561	0.00690	-6.615	0.0000
	Quadratic	0.00351	0.00050	7.061	0.0000
	Cubic	-0.00005	0.00001	-5.367	0.0000
3	Intercept	10.26174	0.06475	158.486	0.0000
	Linear	0.02441	0.01696	1.439	0.1501
	Quadratic	-0.00097	0.00128	-0.756	0.4496
	Cubic	-0.00009	0.00003	-3.166	0.0015
4	Intercept	10.91311	0.02089	522.532	0.0000
	Linear	0.00488	0.00454	1.073	0.2833
	Quadratic	-0.00035	0.00033	-1.055	0.2914
	Cubic	0.00001	0.00001	1.795	0.0726
5	Intercept	11.43465	0.02160	529.334	0.0000
	Linear	0.04462	0.00554	8.060	0.0000
	Quadratic	-0.00341	0.00040	-8.526	0.0000
	Cubic	0.00007	0.00001	9.208	0.0000
	Sigma	0.92239	0.00229	403.182	0.0000
	Group membership				
1	(%)	4.67995	0.40924	11.436	0.0000
2	(%)	21.52920	0.93135	23.116	0.0000
3	(%)	2.90901	0.32886	8.846	0.0000
4	(%)	43.43100	1.12675	38.545	0.0000
5	(%)	27.45083	1.27455	21.538	0.0000

BIC=-114644.2 (N=82859) BIC=-114603.8 (N=3252) AIC=-114527.7 L=-114502.7

Graph F: 5 Group Model with 4th Group Quadratic



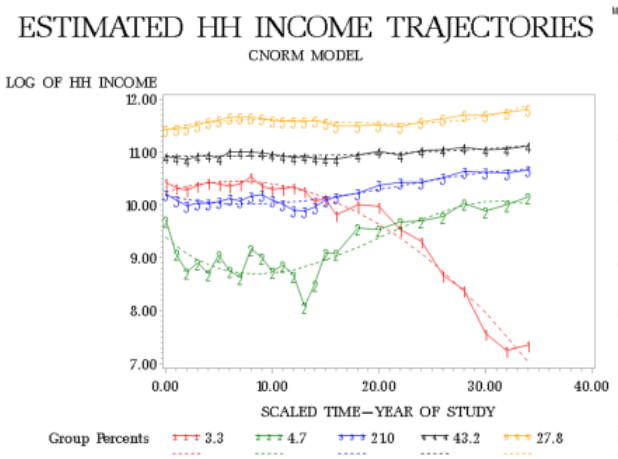
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.26025	0.06471	158.560	0.0000
	Linear	0.02418	0.01700	1.423	0.1548
	Quadratic	-0.00092	0.00128	-0.717	0.4733
	Cubic	-0.00009	0.00003	-3.225	0.0013
2	Intercept	9.37721	0.05952	157.555	0.0000
	Linear	-0.18085	0.01391	-12.997	0.0000
	Quadratic	0.01370	0.00103	13.348	0.0000
	Cubic	-0.00023	0.00002	-11.097	0.0000
3	Intercept	10.19351	0.02726	373.874	0.0000
	Linear	-0.04492	0.00690	-6.509	0.0000
	Quadratic	0.00344	0.00050	6.931	0.0000
	Cubic	-0.00005	0.00001	-5.225	0.0000
4	Intercept	10.92563	0.01970	554.595	0.0000
	Linear	-0.00241	0.00204	-1.180	0.2381
	Quadratic	0.00023	0.00006	3.967	0.0001
5	Intercept	11.43074	0.02140	534.225	0.0000
	Linear	0.04511	0.00549	8.210	0.0000
	Quadratic	-0.00345	0.00040	-8.710	0.0000
	Cubic	0.00007	0.00001	9.401	0.0000
	Sigma	0.92242	0.00229	403.173	0.0000
	Group membership				
1	(%)	2.89141	0.32714	8.838	0.0000
2	(%)	4.65132	0.40836	11.390	0.0000
3	(%)	21.39153	0.92521	23.121	0.0000
4	(%)	43.27512	1.12394	38.503	0.0000
5	(%)	27.79063	1.26432	21.981	0.0000

BIC=-114640.2 (N=82859) BIC=-114601.3 (N=3252) AIC=-114526.3 L=-114504.3

Graph G: 5 Group Model with 1st and 4th Groups Quadratic

GROUP 5 WITH 1&4 QUADRATIC



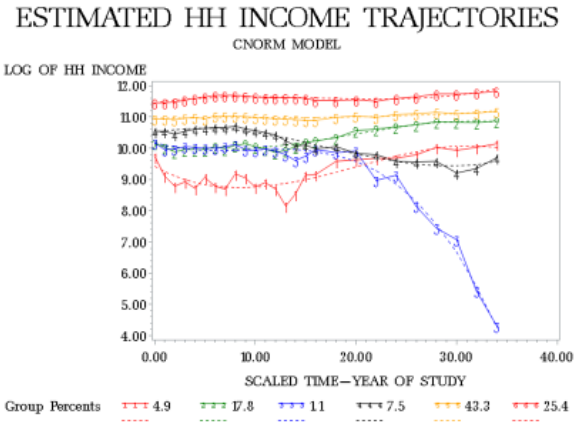
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.24410	0.09865	103.840	0.0000
	Linear	0.06106	0.01283	4.758	0.0000
	Quadratic	-0.00457	0.00048	-9.467	0.0000
2	Intercept	9.38871	0.05651	166.136	0.0000
	Linear	-0.16035	0.01392	-12.955	0.0000
	Quadratic	0.01350	0.00104	12.979	0.0000
	Cubic	-0.00022	0.00002	-10.905	0.0000
3	Intercept	10.16041	0.03036	335.298	0.0000
	Linear	-0.04786	0.00713	-6.716	0.0000
	Quadratic	0.00387	0.00056	6.944	0.0000
	Cubic	-0.00006	0.00001	-5.431	0.0000
4	Intercept	10.93043	0.01911	572.064	0.0000
	Linear	-0.00293	0.00207	-1.412	0.1579
	Quadratic	0.00024	0.00006	4.054	0.0001
5	Intercept	11.42999	0.02135	535.393	0.0000
	Linear	0.04505	0.00549	8.209	0.0000
	Quadratic	-0.00344	0.00040	-8.695	0.0000
	Cubic	0.00007	0.00001	9.384	0.0000
	Sigma	0.92216	0.00230	401.042	0.0000
	Group membership				
1	(%)	3.28678	0.44079	7.457	0.0000
2	(%)	4.71508	0.40456	11.655	0.0000
3	(%)	20.97152	0.97353	21.542	0.0000
4	(%)	43.20860	1.12611	38.370	0.0000
5	(%)	27.81802	1.24654	22.316	0.0000

BIC=-114639.3 (N=82859) BIC=-114602.1 (N=3252) AIC=-114532.1 L=-114509.1

Graph H: 6 Group Model

Cubic 6 group model, 1980-2014



- Worse fit: evidenced by the many similar curves of similar shape
- Less than 3% of data in a group

Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.40473	0.05820	161.580	0.0000
	Linear	-0.17510	0.01470	-11.909	0.0000
	Quadratic	0.01317	0.00113	11.707	0.0000
	Cubic	-0.00022	0.00002	-9.756	0.0000
2	Intercept	10.12365	0.02996	337.947	0.0000
	Linear	-0.06511	0.00767	-8.494	0.0000
	Quadratic	0.00633	0.00055	11.581	0.0000
	Cubic	-0.00011	0.00001	-10.475	0.0000
3	Intercept	10.19115	0.09424	108.141	0.0000
	Linear	-0.09870	0.02636	-3.745	0.0002
	Quadratic	0.01143	0.00195	5.860	0.0000
	Cubic	-0.00040	0.00004	-10.154	0.0000
4	Intercept	10.46903	0.04540	230.595	0.0000
	Linear	0.07053	0.01180	5.979	0.0000
	Quadratic	-0.00840	0.00086	-9.821	0.0000
	Cubic	0.00016	0.00002	9.647	0.0000
5	Intercept	10.95462	0.01873	584.846	0.0000
	Linear	0.00251	0.00448	0.559	0.5761
	Quadratic	-0.00024	0.00033	-0.742	0.4581
	Cubic	0.00001	0.00001	1.717	0.0859
6	Intercept	11.44989	0.02177	525.977	0.0000
	Linear	0.04705	0.00567	8.297	0.0000
	Quadratic	-0.00355	0.00041	-8.677	0.0000
	Cubic	0.00008	0.00001	9.261	0.0000
	Sigma	0.91031	0.00226	402.906	0.0000

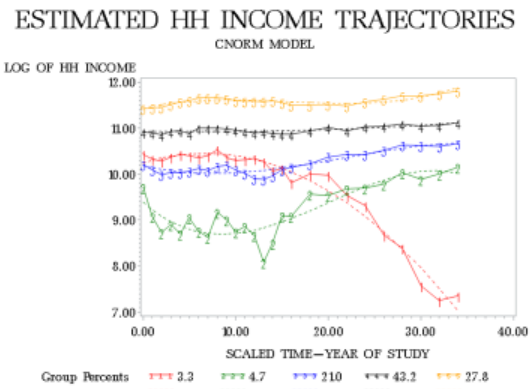
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	(%)	4.89456	0.42748	11.450	0.0000
2	(%)	17.78774	0.83079	21.411	0.0000
3	(%)	1.13730	0.18809	6.047	0.0000
4	(%)	7.52187	0.57169	13.157	0.0000
5	(%)	43.29325	1.10665	39.121	0.0000
6	(%)	25.36528	1.14717	22.111	0.0000

BIC=-113818.3 (N=82859) BIC=-113869.7 (N=3252) AIC=-113778.4 L=-113748.4

Graph I: Final 5-Group Model

For the final 5 group model*, the most parsimonious model (with 2 quadratic trajectories) was selected



Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.24410	0.09865	103.840	0.0000
	Linear	0.06106	0.01283	4.758	0.0000
	Quadratic	-0.00457	0.00048	-9.467	0.0000
2	Intercept	9.38871	0.05651	166.136	0.0000
	Linear	-0.18035	0.01392	-12.955	0.0000
	Quadratic	0.01350	0.00104	12.979	0.0000
	Cubic	-0.00022	0.00002	-10.905	0.0000
3	Intercept	10.18041	0.03036	335.298	0.0000
	Linear	-0.04786	0.00713	-6.716	0.0000
	Quadratic	0.00387	0.00056	6.944	0.0000
	Cubic	-0.00006	0.00001	-5.431	0.0000
4	Intercept	10.93043	0.01911	572.064	0.0000
	Linear	-0.00293	0.00207	-1.412	0.1579
	Quadratic	0.00024	0.00006	4.054	0.0001
5	Intercept	11.42999	0.02135	535.393	0.0000
	Linear	0.04505	0.00549	8.209	0.0000
	Quadratic	-0.00344	0.00040	-8.695	0.0000
	Cubic	0.00007	0.00001	9.384	0.0000
	Sigma	0.92216	0.00230	401.042	0.0000
	Group membership				
1	(%)	3.28678	0.44079	7.457	0.0000
2	(%)	4.71508	0.40456	11.655	0.0000
3	(%)	20.97152	0.97353	21.542	0.0000
4	(%)	43.20860	1.12611	38.370	0.0000
5	(%)	27.81802	1.24654	22.316	0.0000

BIC=-114639.3 (N=82859) BIC=-114602.1 (N=3252) AIC=-114532.1 L=-114509.1

*Chart was reconverted to raw income values (inv (log)) before labeling groups

Table J: Tabulated BIC for Model Fitting Process

Tabulated Baysian Information Criterion (BIC) and 2log (B_{10})

Number of Groups, Ordering of Trajectories	*BIC*	*Null Model*	*2log (B_{10})*
2	-119573.6	-	-
3	-117184.0	2	4779.2
4	-115541.4	3	3285.2
4, with G1 quadratic	-115539.8	4	3.2
5	-114603.8	4, G1 quadratic	1872
5, with G4 quadratic	-114601.3 *	5	5.0
5, with G1 & G4 quadratic	-114602.1	5, G4 quadratic	-1.6
6	*-113869.7*		

2log(B10) is calculated as 2 x (difference in BIC), or the degree of evidence favoring the alternate model.*
*Based on the above results, the 5 group model with one quadratic trajectory provides moderate evidence for the selection of the simpler model (when compared to the 5 group cubic model), and very strong evidence for the selection of the more complex model (when compared to the 4 group quadratic trajectory model). The 5 group model with 2 quadratic trajectories provides slightly worse fit, but was a more parsimonious alternative to the 5 group model with one quadratic trajectory and was thus selected as the final model. (The 6 group model was eliminated as feasible option for the final model by the researcher: a trajectory group contained less than 2% of the data, similarity of trajectories of groups 2,4,5 and 6)

*Evidentiary criteria established by Jones, et al 2001.

Appendix C: Association of Life Course Income Group with Prevalence Psychological Distress Among Adults 35-50 years old, all model covariates

	Unadjusted	Model 1	Model 2	Model 3
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Income Trend				
Low-mid decreasing	12.85 (6.24, 26.44)	10.14 (4.44, 23.15)	3.18 (1.17, 8.68)	3.51 (1.33, 9.26)
Low	5.32 (2.52, 11.23)	4.43 (1.68, 11.65)	2.69 (1.07, 6.77)	2.49 (1.10, 5.64)
Low-mid increasing	4.92 (2.80, 8.65)	4.67 (2.45, 8.91)	2.96 (1.43, 6.14)	2.45 (1.18, 5.09)
Stable Middle	3.05 (1.83, 5.10)	2.97 (1.71, 5.16)	2.26 (1.34, 3.81)	2.05 (1.27, 3.31)
High	1.00	1.00	1.00	1.00
*Age in years**		.	.	-0.01 (-0.04, 0.03)
Female		1.08 (0.87, 1.35)	1.18 (0.93, 1.49)	1.07 (0.83, 1.39)
Race				
White vs. Black (ref)		1.30 (0.83, 2.06)	1.32 (0.81, 2.15)	0.86 (0.54, 1.36)
Marital Status				
Sep/Wid/Divorced		2.15 (1.29, 3.57)	2.05 (1.24, 3.40)	1.65 (0.99, 2.76)
Single		1.63 (1.02, 2.61)	1.58 (0.95, 2.64)	1.30 (0.79, 2.13)
Married		1.00	1.00	1.00
Educational Level				
Less than HS			1.91 (0.88, 4.16)	2.00 (0.93, 4.30)
HS Degree			1.87 (1.01, 3.46)	2.16 (1.17, 3.98)
Some college			1.31 (0.69, 2.47)	1.34 (0.71, 2.53)
College Degree			1.27 (0.81, 2.00)	1.26 (0.78, 2.02)
Post-graduate			1.00	1.00

Current occupation		
Unemployed	3.22 (1.63, 6.35)	2.29 (1.08, 4.83)
Blue Collar	1.14 (0.67, 1.94)	1.25 (0.70, 2.23)
Pink Collar	0.76 (0.43, 1.33)	0.72 (0.39, 1.32)
White Collar	1.00	1.00
Ever any psychiatric Dx		6.30 (4.49, 8.84)

**Beta coefficient and LL 95%, UL 95% presented; . = not estimatable*

Appendix D: Association of HDWF-Adjusted Life Course Income Group with Prevalence Psychological Distress Among Adults 35-50 years old*

	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]
	PR (95% CI)[d]	PR (95% CI)	PR (95% CI)	PR (95% CI)
Income Group				
Low-mid decreasing	7.73 (4.40, 13.57)	5.91 (3.19, 10.95)	2.72 (1.25, 5.93)	2.58 (1.29, 5.18)
Low	4.05 (2.08, 7.86)	3.22 (1.45, 7.18)	2.36 (1.12, 5.01)	2.00 (1.04, 3.86)
Low-mid increasing	4.20 (2.49, 7.08)	3.67 (2.11, 6.40)	2.54 (1.34, 4.81)	2.12 (1.16, 3.88)
Stable Middle	2.90 (1.86, 4.53)	2.60 (1.65, 4.10)	2.11 (1.35, 3.30)	1.85 (1.23, 2.78)
High	1.00	1.00	1.00	1.00

*Models fit with exchangeable working correlation and robust variance estimation (SEs).

[a] Model 1 adjusted for demographics: age (in years), race, sex, marital status

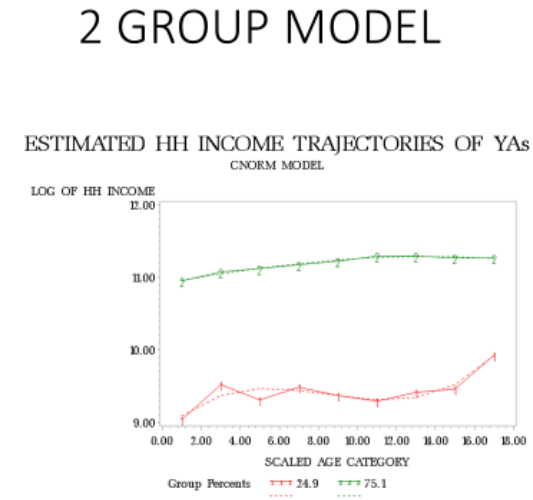
[b] Model 2 adjusted for SEP indicators: current occupation of head, educational level

[c] Model 3 presents income group prevalence ratios for the fully adjusted model- additionally adjusted for any psychiatric/emotional/nervous disorder diagnosis. Models unadjusted for household head status (collinearity-marital status) and past year income quartile (collinearity-income trend, potential mediator, predicted by prior income trend)

[d] PR=prevalence ratio, 95% CI=confidence interval

Appendix E: Graphs A-E: Model fitting for N=2411 Young Adults, Life Course Income Trajectories

Graph A: 2 Group Model

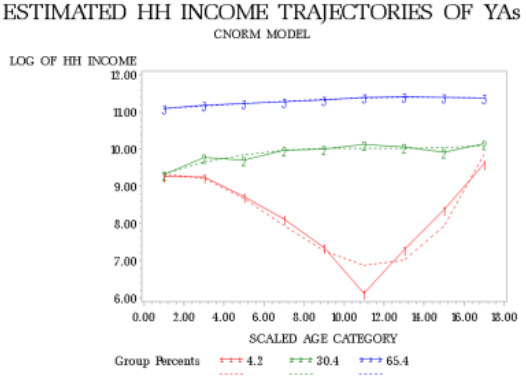


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	8.85398	0.09844	89.942	0.0000
	Linear	0.26492	0.04595	5.766	0.0000
	Quadratic	-0.03566	0.00591	-6.030	0.0000
	Cubic	0.00140	0.00022	6.486	0.0000
2	Intercept	10.91924	0.05181	210.766	0.0000
	Linear	0.04538	0.02470	1.837	0.0662
	Quadratic	-0.00069	0.00319	-0.216	0.8290
	Cubic	-0.00005	0.00012	-0.406	0.6848
	Sigma	1.44598	0.00709	203.924	0.0000
	Group membership				
1	(%)	24.91920	1.14510	21.762	0.0000
2	(%)	75.08080	1.14510	65.567	0.0000

BIC=-39850.25 (N=21657) BIC=-39839.28 (N=2411) AIC=-39810.34 L=-39800.34

Graph B: 3 Group Model

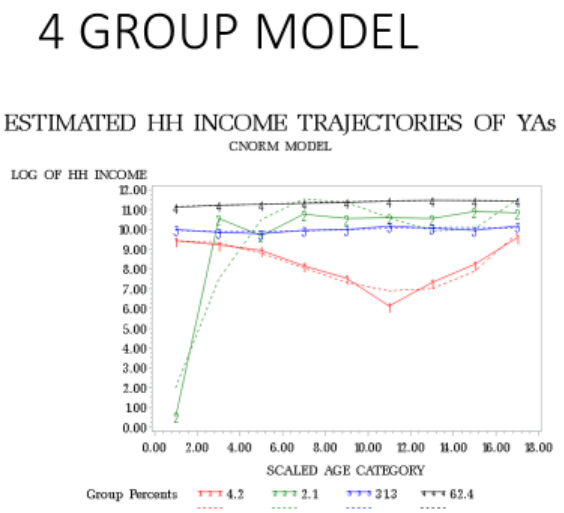


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.16201	0.23972	38.219	0.0000
	Linear	0.26943	0.14526	1.855	0.0636
	Quadratic	-0.09827	0.01972	-4.983	0.0000
	Cubic	0.00499	0.00072	6.949	0.0000
2	Intercept	9.14326	0.09046	101.080	0.0000
	Linear	0.22164	0.04188	5.293	0.0000
	Quadratic	-0.01840	0.00549	-3.350	0.0008
	Cubic	0.00051	0.00020	2.539	0.0111
3	Intercept	11.06976	0.05354	206.743	0.0000
	Linear	0.03240	0.02538	1.277	0.2017
	Quadratic	0.00049	0.00329	0.150	0.8808
	Cubic	-0.00008	0.00012	-0.654	0.5133
	Sigma	1.39360	0.00690	202.024	0.0000
	Group membership				
1	(%)	4.15368	0.49681	8.361	0.0000
2	(%)	30.41735	1.41183	21.545	0.0000
3	(%)	65.42897	1.46733	44.591	0.0000

BIC=-39409.57 (N=21657) BIC=-39393.11 (N=2411) AIC=-39349.70 L=-39334.70

Graph C: 4 Group Model

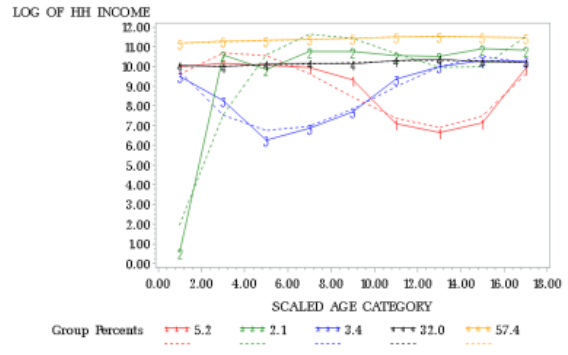


Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.20652	0.21666	42.493	0.0000
	Linear	0.30070	0.13039	2.306	0.0211
	Quadratic	-0.10259	0.01790	-5.730	0.0000
	Cubic	0.00511	0.00066	7.767	0.0000
2	Intercept	-1.98644	0.27048	-7.344	0.0000
	Linear	4.37746	0.13186	33.198	0.0000
	Quadratic	-0.44635	0.01702	-26.232	0.0000
	Cubic	0.01385	0.00062	22.296	0.0000
3	Intercept	10.01561	0.07457	134.316	0.0000
	Linear	-0.07842	0.03839	-2.043	0.0411
	Quadratic	0.01210	0.00504	2.398	0.0165
	Cubic	-0.00043	0.00018	-2.342	0.0192
4	Intercept	11.10162	0.05165	214.920	0.0000
	Linear	0.03060	0.02452	1.248	0.2121
	Quadratic	0.00100	0.00318	0.314	0.7538
	Cubic	-0.00010	0.00012	-0.861	0.3891
	Sigma	1.32883	0.00657	202.215	0.0000
	Group membership				
1	(%)	4.22033	0.49244	8.570	0.0000
2	(%)	2.11525	0.29356	7.205	0.0000
3	(%)	31.31429	1.41959	22.059	0.0000
4	(%)	62.35013	1.51378	41.188	0.0000

BIC=-38654.25 (N=21657) BIC=-38632.30 (N=2411) AIC=-38574.42 L=-38554.42

Graph D: 5 Group Model



Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	8.44366	0.17564	48.073	0.0000
	Linear	1.37716	0.09197	14.973	0.0000
	Quadratic	-0.23873	0.01217	-19.608	0.0000
	Cubic	0.00951	0.00045	21.195	0.0000
2	Intercept	-2.06888	0.26438	-7.825	0.0000
	Linear	4.45321	0.12871	34.598	0.0000
	Quadratic	-0.45532	0.01662	-27.402	0.0000
	Cubic	0.01414	0.00061	23.287	0.0000
3	Intercept	11.45344	0.24089	47.546	0.0000
	Linear	-1.96605	0.12425	-15.823	0.0000
	Quadratic	0.24401	0.01619	15.075	0.0000
	Cubic	-0.00781	0.00059	-13.335	0.0000
4	Intercept	10.06579	0.07355	136.865	0.0000
	Linear	-0.04084	0.03603	-1.133	0.2570
	Quadratic	0.01047	0.00471	2.222	0.0263
	Cubic	-0.00045	0.00017	-2.627	0.0086
5	Intercept	11.15967	0.05200	214.614	0.0000
	Linear	0.02724	0.02464	1.106	0.2689
	Quadratic	0.00148	0.00319	0.465	0.6418
	Cubic	-0.00012	0.00012	-0.999	0.3179
	Sigma	1.28742	0.00640	201.194	0.0000
	Group membership				
1	(%)	5.17498	0.49371	10.482	0.0000
2	(%)	2.07419	0.29072	7.135	0.0000
3	(%)	3.37558	0.41803	8.075	0.0000
4	(%)	32.00367	1.51766	21.088	0.0000
5	(%)	57.37158	1.58389	36.222	0.0000

BIC=-38302.21 (N=21657) BIC=-38274.77 (N=2411) AIC=-38202.42 L=-38177.42

Graph E: Final 5-Group Model with 5th Group Quadratic

5 GROUP MODEL WITH GROUP 5 QUADRATIC

Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

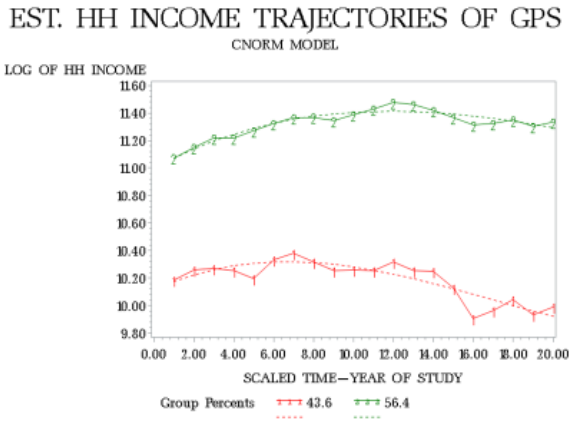
Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	8.44377	0.17563	48.078	0.0000
	Linear	1.37673	0.09198	14.967	0.0000
	Quadratic	-0.23866	0.01218	-19.600	0.0000
	Cubic	0.00951	0.00045	21.188	0.0000
2	Intercept	-2.06894	0.26437	-7.826	0.0000
	Linear	4.45319	0.12871	34.598	0.0000
	Quadratic	-0.45531	0.01662	-27.402	0.0000
	Cubic	0.01414	0.00061	23.286	0.0000
3	Intercept	11.45273	0.24093	47.536	0.0000
	Linear	-1.96570	0.12428	-15.817	0.0000
	Quadratic	0.24397	0.01619	15.068	0.0000
	Cubic	-0.00781	0.00059	-13.329	0.0000
4	Intercept	10.06791	0.07346	137.058	0.0000
	Linear	-0.04206	0.03598	-1.169	0.2425
	Quadratic	0.01065	0.00470	2.263	0.0236
	Cubic	-0.00046	0.00017	-2.671	0.0076
5	Intercept	11.12481	0.03845	289.355	0.0000
	Linear	0.05000	0.00936	5.340	0.0000
	Quadratic	-0.00166	0.00051	-3.291	0.0010
	Sigma	1.28745	0.00640	201.190	0.0000
	Group membership				
1	(%)	5.17584	0.49369	10.484	0.0000
2	(%)	2.07418	0.29072	7.135	0.0000
3	(%)	3.37550	0.41808	8.074	0.0000
4	(%)	32.02941	1.51839	21.094	0.0000
5	(%)	57.34507	1.58480	36.184	0.0000

BIC=-38297.72 (N=21657) BIC=-38271.38 (N=2411) AIC=-38201.92 L=-38177.92

Appendix F: Graphs A-D: Model Fitting, Grandparent's 20-yr Income Trajectories

Graph A: 2 Group Model

2 GROUP MODEL



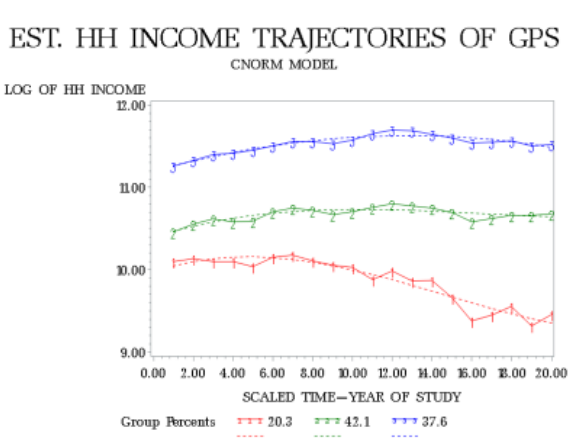
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	10.11090	0.02697	374.916	0.0000
	Linear	0.06786	0.01082	6.274	0.0000
	Quadratic	-0.00633	0.00118	-5.348	0.0000
	Cubic	0.00012	0.00004	3.324	0.0009
2	Intercept	10.99936	0.02369	464.214	0.0000
	Linear	0.07860	0.00947	8.298	0.0000
	Quadratic	-0.00444	0.00104	-4.280	0.0000
	Cubic	0.00006	0.00003	1.916	0.0553
	Sigma	0.72007	0.00254	282.938	0.0000
	Group membership				
1	(%)	43.58264	1.15210	37.829	0.0000
2	(%)	56.41736	1.15210	48.969	0.0000

BIC=-45187.71 (N=40183) BIC=-45172.75 (N=2014) AIC=-45144.71 L=-45134.71

Group B: 3 Group Model

3 GROUP MODEL



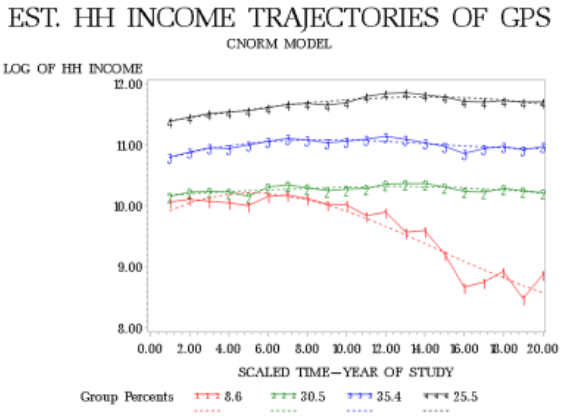
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.97187	0.03841	259.647	0.0000
	Linear	0.08311	0.01567	5.305	0.0000
	Quadratic	-0.01041	0.00174	-5.969	0.0000
	Cubic	0.00024	0.00005	4.350	0.0000
2	Intercept	10.39287	0.02646	392.757	0.0000
	Linear	0.07786	0.01061	7.336	0.0000
	Quadratic	-0.00550	0.00116	-4.745	0.0000
	Cubic	0.00011	0.00004	3.077	0.0021
3	Intercept	11.20326	0.02751	407.239	0.0000
	Linear	0.06464	0.01079	5.989	0.0000
	Quadratic	-0.00225	0.00118	-1.905	0.0568
	Cubic	-0.00001	0.00004	-0.370	0.7111
	Sigma	0.66778	0.00237	282.221	0.0000
	Group membership				
1	(%)	20.30213	1.06946	18.984	0.0000
2	(%)	42.08790	1.19168	35.318	0.0000
3	(%)	37.60997	1.19196	31.553	0.0000

BIC=-42846.76 (N=40183) BIC=-42824.31 (N=2014) AIC=-42782.26 L=-42767.2

Graph C: 4 Group Model

4 GROUP MODEL



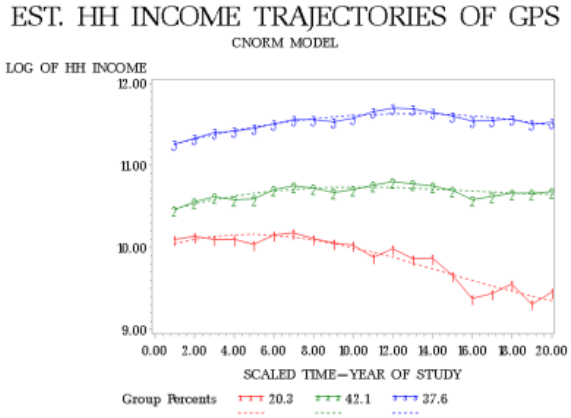
Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.74829	0.05534	176.148	0.0000
	Linear	0.19471	0.02254	8.637	0.0000
	Quadratic	-0.02306	0.00247	-9.353	0.0000
	Cubic	0.00052	0.00008	6.739	0.0000
2	Intercept	10.15548	0.02898	350.464	0.0000
	Linear	0.01935	0.01165	1.661	0.0967
	Quadratic	0.00003	0.00128	0.025	0.9801
	Cubic	-0.00004	0.00004	-1.085	0.2781
3	Intercept	10.68674	0.02805	380.962	0.0000
	Linear	0.10822	0.01077	10.045	0.0000
	Quadratic	-0.00897	0.00118	-7.609	0.0000
	Cubic	0.00021	0.00004	5.663	0.0000
4	Intercept	11.34700	0.03200	354.556	0.0000
	Linear	0.05008	0.01262	3.967	0.0001
	Quadratic	-0.00039	0.00138	-0.282	0.7779
	Cubic	-0.00007	0.00004	-1.531	0.1259
	Sigma	0.63787	0.00226	281.861	0.0000
	Group membership				
1	(%)	8.57246	0.66039	12.981	0.0000
2	(%)	30.50279	1.08308	28.163	0.0000
3	(%)	35.44025	1.17385	30.192	0.0000
4	(%)	25.48451	1.10713	23.018	0.0000

BIC=-41460.74 (N=40183) BIC=-41430.81 (N=2014) AIC=-41374.73 L=-41354.73

Graph D: Final 3 Group Model with 3rd Group Quadratic

FINAL 3 GROUP MODEL WITH G3 QUADRATIC



Maximum Likelihood Estimates
Model: Censored Normal (CNORM)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
1	Intercept	9.97177	0.03841	259.646	0.0000
	Linear	0.08318	0.01566	5.311	0.0000
	Quadratic	-0.01042	0.00174	-5.977	0.0000
	Cubic	0.00024	0.00005	4.356	0.0000
2	Intercept	10.39283	0.02646	392.751	0.0000
	Linear	0.07775	0.01061	7.330	0.0000
	Quadratic	-0.00548	0.00116	-4.736	0.0000
	Cubic	0.00011	0.00004	3.066	0.0022
3	Intercept	11.19598	0.01924	581.977	0.0000
	Linear	0.06834	0.00406	16.833	0.0000
	Quadratic	-0.00269	0.00019	-14.192	0.0000
	Sigma	0.66778	0.00237	282.224	0.0000
	Group membership				
1	(%)	20.29432	1.06826	18.997	0.0000
2	(%)	42.08577	1.19151	35.321	0.0000
3	(%)	37.61991	1.19145	31.575	0.0000

BIC=-42841.53 (N=40183) BIC=-42820.58 (N=2014) AIC=-42781.32 L=-42767.32

Appendix G: Sensitivity Analysis: Young Adult Income with Grandparent Income Trend Adjustment and Distress

	Unadjusted	**Model 1[a]**	**Model 2[b]**	**Model 3[c]**
	PR (95% CI)[d]	PR (95% CI)	PR (95% CI)	PR (95% CI)
Income Group				
Low, Lower, Low	1.02 (0.57, 1.82)	1.06 (0.62, 1.83)	0.91 (0.51, 1.60)	0.78 (0.36, 1.71)
Middle fluctuating	1.37 (0.73, 2.59)	1.47 (0.77, 2.82)	1.32 (0.64, 2.72)	2.60 (0.64, 2.72)
Very Low Upwards Plateau	1.32 (0.77, 2.27)	1.26 (0.72, 2.21)	1.27 (0.73, 2.20)	0.49 (0.19, 1.30)
Lower middle steady	1.39 (1.02, 1.90)	1.38 (0.98, 1.95)	1.32 (0.93, 1.87)	1.46 (1.07, 1.99)
High	1.00	1.00	1.00	1.00
Wald chi-square (GP income group)				1.92 (*p=0.3836*)
Adjusted F-test (overall model)			19.71 (*p<0.0001*)	19.99 (*p<0.0001)*

[a] Model 1 adjusted for young adult characteristics: survey year, race, sex, age category, relationship status

[b] Model 2 adjusted for parent characteristics: psychiatric diagnosis/ever (any parent), parent marital status, parents' highest education

[c] Model 3 additionally adjusted for grandparents' income trend (low, middle, high)

[d] PR=prevalence ratio, 95% CI=confidence interval

LIST OF FOOTNOTES

1.) Sample selection procedure for GBTM of income closely follows that outlined by Cerda, M et al in "Lifetime income patterns and alcohol consumption: Investigating the association between long and short-term income trajectories and drinking". *Soc Sci Med.* 2011 October; 73(8): 1178–1185.

2.) SEP covariate selection informed by Cerda M et al. "Lifetime income patterns and alcohol consumption: Investigating the association between long and short-term income trajectories and drinking". *Soc Sci Med.* 2011 October; 73(8): 1178–1185.

3.) GBTM fitting procedure as applied by Johnson-Lawrence, VD et al, 2015 in "Cumulative socioeconomic disadvantage and cardiovascular disease mortality in the Alameda County Study 1965 to 2000." *Annals of Epidemiology.* 2015; 25: 65-70.

4.) The age range was restricted to 17-20 to capture parental income trajectories before the transition to adulthood; 7 was the minimum number of income assessments needed to span all stages of the life course from birth or infancy to 16 years of age for all participants.

5.) Similar to the approach used by Ward JB, et al in "Intergenerational educational mobility and depressive symptoms in a population of Mexican origin." *Annals of Epidemiology.* 2016; 26: 461-466.

ACKNOWLEDGEMENT OF PREVIOUS PUBLICATIONS

1.) **Cerda M, et al 2011:** "Lifetime income patterns and alcohol consumption: Investigating the association between long- and short-term income trajectories." Our first paper was closely informed by this publication, with reference to the sample selection process of heads/wives, Proc Traj income assessment minimum, log-binomial model SEP covariate selection and measurement, income modeling application, and GBTM results presentation. As such, our first paper also had similar limitations.

2.) **Johnson-Lawrence V, et al 2015: "**Cumulative Socioeconomic Disadvantage and Cardiovascular Disease Mortality in the Alameda County Study 1965-2000" for guidance on how to run the Proc Traj group-based trajectory modeling procedure for income.

3.) **Li, Miao 2015:** "Chronic Exposure of Grandparents to Poverty and Body Mass Index Trajectories of Grandchildren: A Prospective Intergenerational Study" for accumulative SEP hypotheses of familial transmission and for outlining the process of grandparent to grandchild linking in the PSID.

4.) **Ward, J et al 2016:** "Intergenerational educational mobility and depressive symptoms in a population of Mexican origin." for the application and categorization of the intergenerational trajectories.

5.) **Arrandale VH- 2006:** "How to use SAS Proc Traj and SAS Proc Glimmix in Respiratory Epidemiology" document, which was part of an MSc Thesis: "An evaluation of two existing methods for analyzing longitudinal respiratory symptom data". Vancouver: University of British Columbia, 2006. The author found this to be a helpful

introductory document for how to set up and code your data for Proc Traj. It also includes simple syntax/code in order to run a Proc Traj model.

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