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Internal migration and depressive symptoms: Exploring selection and outcomes in a South African cohort

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ABSTRACT

Introduction: Investigations of migration effects on mental health conditions, including depression are sparse in low- and middle-income countries (LMIC), yet mental health may play a role in a decision to migrate, and migration in turn can impact on mental health outcomes.
Methods: This paper uses two waves of data from the Migrant Health Follow-Up Study, a young adult cohort of 2967 internal migrants and residents of the Agincourt study site in rural northeast South Africa to explore the relationship between internal migration and depressive symptoms, as measured on the Center for Epidemiological Studies Depression (CES-D) scale. We employ logistic regression analysis to investigate selectivity of migrants in relation to depressive symptoms, and we fit generalized linear models to analyse depressive symptoms (CES-D scores) as a function of migration status and sociodemographic and health characteristics, accounting for temporal sequence.
Results: Although we observe systematically low reporting of depressive symptoms, average CES-D scores are lower among migrants (comprising approximately 53% of the cohort) compared to Agincourt residents at both survey timepoints. We do not find evidence of a selection effect in relation to mental health among those newly migrating between Wave 2 and 3 (n = 1393). In analyses of the CES-D score outcome, the significant influence of migration status on depressive symptoms is reduced with the inclusion of controls in the models. Consistent employment and higher levels of education are associated with lower CES-D scores, while diagnosis of a chronic condition is associated with higher scores.
Conclusion: The relationship between migration and depressive symptoms is influenced by factors preceding a migration and destination-place characteristics and experiences. Further examination of the role of migration at different stages of the process, along with continuing attention to psychosocial measurement considerations for LMIC subpopulations, can improve our understanding of these complex interrelationships and contribute to evidence.

1. Introduction

Research on the relationship between migration and health is expanding in recognition of rising prevalence of mobility globally and its diverse impacts on health and well-being outcomes. To this end, there is a growing body of work examining the relationship between migration and mental health conditions, including depression (Arias et al., 2022; Lund et al., 2018; Sweileh et al., 2018). Depression, which is characterised by pervasive low mood and lack of interest or pleasure in usual activities (alongside other somatic and cognitive features), significantly impacts on individual quality of life, and is linked to comorbidity (World Health Organization, 2017; Cassano and Fava, 2002). In the recent

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Global Burden of Disease (GBD) study, mental disorders were among the leading contributors to the world's disease burden, with depressive disorders being a leading cause of disability (COVID-19 Mental Disorders Collaborators, 2021; GBD, 2019 Mental Disorders Collaborators, 2022). Worldwide, the prevalence of depressive disorders in 2019 was estimated at 279.6 million cases (increasing from 170.8 million cases in 1990), with variations by age, gender and region observed (GBD, 2019 Mental Disorders Collaborators, 2022). The GBD Consortium and World Health Organization have acknowledged gaps in epidemiological data on mental disorders and a predominance of high-income country data in informing estimates (GBD, 2019 Mental Disorders Collaborators, 2022; World Health Organization, 2022). More representation of low- and middle-income country (LMIC) settings in depression-related research is needed.

1.1. Migration and health

The role of migration on health is varied and bidirectional. Structural, community and individual-level factors (including health) may drive a migration decision (Castañeda et al., 2015), while migration brings about changes in the physical environment, typically necessitates severing and re-establishing community and neighbourhood-level ties and affects a range of individual socioeconomic and lifestyle factors. Health consequences of migration may be favourable, but migration has also been associated with risks for health conditions through altered exposures, changes in health-related behaviours, stress as a result of relocation, and interrupted access to health care (Abubakar et al., 2018; Nauman et al., 2016). The relationship between migration and health is made more complex by the fact that geographic mobility is understood as a highly selective process - migrants are rarely a simple representation of an origin population. "Migration differentials" along several characteristics such as age, gender, occupation and family status have long been noted in the literature (Thomas, 1938). Accumulated evidence for health selection along the dimension of physical health has been codified into the notion of the "healthy migrant effect". While a simple migrant/non-migrant health differential (favouring migrants) is often observed, sorting out chronology and the competing contribution of the migratory process itself versus destination living circumstances is more challenging, especially when those undertaking migration may already differ substantially before they move (Nauman et al., 2016).

Investigations of migration effects on mental health have commonly focused on international migration prompted by economic and political drivers, or due to forced displacement, often from low- to high-income country destinations (Abubakar et al., 2018; Bhugra, 2004; Lindert et al., 2009). The impacts of international geographic mobility on mental health are diverse: a number of studies of refugee populations have found poor mental health outcomes including increased stress, depression and anxiety associated with migration (Close et al., 2016; Henkelmann et al., 2020; International Organization for Migration, 2020; James et al., 2022), while other studies focused on voluntary economic migration have found negligible mental health impacts (Foo et al., 2018).

Evidence on the internal migration and mental health relationship is less well established, although internal migration, involving intra-country moves, occurs at a much greater scale than international migration (Bell and Muhidin, 2009). It is likely that the relationships between internal migration and mental health differ from those observed in the context of international migration given the different drivers of movement, the prominence of labour migration in these settings, and the different contextual challenges faced. A limited number of studies have explored mental health effects of internal migration within LMICs in the context of rural to urban movement and urbanisation - in which migrants are typically seen as making moves to places of greater density, heterogeneity, and complexity. These studies, predominantly set in China or South-East Asia, have yielded mixed findings, however. Some find internal migration to be associated with improved general mental health (Nauman et al., 2015) and lower depression levels (Zhang et al., 2022). Other studies find no relationship between general mental health and migration (Anglewicz et al., 2017), or they find mental health deterioration in the form of depressive symptoms or psychological stress after migration (Chen, 2011; Harpham, 1994; Lu, 2010b). Important additional factors affecting this relationship are gender (women have been found to exhibit more depressive symptoms following migration (Lu, 2010a)), socioeconomic status, living conditions, and social support (Harpham, 1994). Findings showing improved mental health following a move are often interpreted as an adaptation or acculturation effect (Urquia and Gagnon, 2011); conversely, increased exposure to stressful work, living and social conditions may also plausibly explain deteriorations in mental health status among migrants (Zaami, 2022).

In relation to health status preceding migration, empirical evidence of migrant selectivity along the lines of mental health has been quite sparse, especially in LMIC and transition economy contexts. A study in Malawi found women migrants were negatively selected on general mental health (Anglewicz et al., 2018), while studies conducted in Asia have noted either no direct effect of depressive symptoms on migration (Lu, 2010a) or poorer general mental health (Nauman et al., 2015) associated with the propensity to migrate.

1.2. Internal migration in South Africa

The relationship between internal migration and mental health has rarely been explicitly tested in sub-Saharan Africa, where risk factors for health conditions are often exacerbated by poverty and inequality. South Africa represents an appropriate setting for the study of internal migration and mental health, and the South African experience is likely to be informative for countries at earlier stages of health transition. South Africa is characterised by pervasive health and social inequalities (Lund and Cois, 2018) with a high burden of infectious disease (HIV/TB), non-communicable disease and injuries (Achoki et al., 2022). In addition, levels of internal migration in South Africa are high, having evolved as a consequence of apartheid, into contemporary, routinized, and prevalent patterns of rural-urban and circular migration (Collinson et al., 2006; Hosegood et al., 2005; Posel, 2020). Men and women from rural origin areas move in search of employment, which is often insecure and/or informal. The negative mental health consequences of migration, in conjunction with apartheid, have been acknowledged (Dommisse, 1986; Hickson and Kriegler, 1991; World Health Organization, 1977), but we still have a limited understanding of how contemporary migration under the legacy of apartheid affects mental health today.

In the present study we take advantage of cohort survey data to hone our understanding of the relationship between migration and depressive symptoms in South Africa and to identify potentially confounding influences. We include indicators of personal sociodemographic characteristics and physical health as we examine depressive symptoms and internal migration. The Migrant Health Follow-Up Study (MHFUS) draws participants from the Agincourt Health and socio-Demographic Surveillance System (HDSS), a geographically defined observation platform in a low-resource environment in rural northeast South Africa. The MHFUS focuses directly on internal migration, much of which constitutes rural-urban movement, and it thus able to add appreciably to the evidence base on internal migration and mental health in LMICs. Employing a novel study design which recruits from a rural community with many sociogeographic conditions in common, we are able to draw robust comparisons between movers and those who stay behind. Furthermore, we employ longitudinal data which allow us to explore health and social conditions pre-migration and post-migration, and monitor changes over time (Anglewicz et al., 2018) – few datasets are able to examine both selection effects and outcomes.

The objectives of this study are 1) to explore the likelihood of experiencing depressive symptoms among migrants and Agincourt study site residents using data from two study waves of the MHFUS spanning the period 2019–2021; 2) to investigate whether migrants are selected

on depressive symptoms; and 3) to examine the relationship between migration and outcome, depressive symptoms, controlling for socio-demographic and health factors.

2. Methods

2.1. Study population and sample

The MHFUS is a nested cohort study of the Agincourt HDSS platform. The Agincourt HDSS, established in 1992, maintains an ongoing enumeration of the full population of a 420 square kilometre area in the Mpumalanga Province in South Africa's rural northeast (Kahn et al., 2012). The MHFUS commenced in 2017 with the recruitment of individuals from a simple random sample of 3800 18- to 40-year-olds who were part of the Agincourt HDSS population at the time of the 2016 HDSS census. The HDSS population from which the MHFUS sample was drawn was defined by all individuals who were listed in the roster of each household (usually reported by the household head) in the 2016 annual enumeration of the 31 villages in the Agincourt HDSS. This roster includes current residents within the Agincourt study site, as well as those living in other locations across South Africa for most of the year but who maintain connections to the household. At MHFUS Wave 1, 57% of the sample were residents of the Agincourt study site, while 43% were living away from the study site (migrants). From enrolment the MHFUS has followed all participants, migrants and Agincourt study site residents, no matter their subsequent origin household attachment.

Wave 1 of data collection on the cohort took place in 2018 via in-person interviews. Waves 2 and 3 occurred via telephone interviews, between September 2019 and January 2020 and September 2020 to March 2021 respectively. We successfully recruited and interviewed 3092 respondents in Wave 1 and retained 95.9% of this cohort through Wave 3 (see Ginsburg et al., 2021; Ginsburg et al., 2024 for details on initial participation, eligibility, and recruitment methods). In the present analysis, we use data from Waves 2 and 3 since we introduced measures on mental health for the first time in the Wave 2 survey and collected these again in Wave 3. Wave 3 telephone interviews all took place during the COVID-19 pandemic, prior to the vaccine roll-out, when nonpharmaceutical interventions were in place across the country (Ginsburg et al., 2022). The analytic sample for this study includes participants who responded to both the Wave 2 and 3 interviews (n = 2967).

2.2. Variables and measures

At each wave, core questions on residence history and migration, education, employment and health status (including chronic conditions and health service use) were asked. Questionnaires were administered using REDCap electronic data capture software (Harris et al., 2009, 2019).

We define a "migrant" as a participant who was living away from the Agincourt study site in any given wave of the study. Due to high prevalence of circular and temporary migration in this population, a participant's migration status may be classified as:

1) a *continuing migrant* if they lived outside of the Agincourt study site for consecutive waves;
2) a *new migrant* if they transitioned from residing within the Agincourt study site to residing outside of it between the two waves;
3) a *return migrant* if they moved back from a migration destination to the Agincourt study site between the two waves.

We introduced the 10-item Center for Epidemiological Studies Depression Scale (CES-D) depression screening tool in Wave 2 to determine the presence of depressive symptoms in the study population (Adams et al., 2020; Radloff, 1977). The scale was translated and back translated (into and from the local language, xi-Tsonga) and administered by a team of experienced and trained fieldworkers via telephone. The CES-D score is based on the sum of responses to 10 questions asking about the way a person may have felt or behaved during the past week. In accordance with the screening tool protocol, two response categories, item 5 (I felt hopeful about the future) and item 8 (I was happy), were asked and then reverse coded. The 10-item alpha inter-item score was 0.66 in Wave 2 and 0.78 in Wave 3 indicating lower internal consistency in Wave 2. In-depth explorations of each item of the CES-D 10 revealed some inconsistency in the responses by fieldworkers for item 4 "I felt that everything I did was an effort". Following further engagement with fieldworkers, we attribute this to some ambiguity in the question following its translation into xi-Tsonga. After careful consideration of the potential error introduced by including all 10 items—as is conventional—we made the statistically conservative decision to remove this item and constructed a 9-item CES-D score for Waves 2 and 3 that excluded item 4, with alpha values of 0.84 and 0.76, respectively. Still, we ran all models with both 9- and 10-item versions of the CES-D and found consistent results. We present analyses using the modified continuous CES-D 9-item score (in theory ranging up to 27 but maximized at 20 in our sample) to allow for differentiation along a continuum of depressive symptom severity.

The analyses include sociodemographic variables (time varying where applicable): gender, age, education and employment status, measures of physical health (diagnosis of a chronic condition) and migration status variables. We further include in our analyses of depressive symptoms a measure of perceived social support using a scale adapted from Zimet et al. which is based on the sum of 11 items with scores ranging from 1 to 4 (Rothschild, 2019; Turner et al., 2010; Zimet et al., 1990). The relevant extract of the MHFUS questionnaire for Wave 2 is available in Appendix A (the same set of questions were included in the Wave 3 questionnaire).

2.3. Statistical analysis

2.3.1. Descriptive analyses

To meet our first objective (to describe the likelihood of experiencing depressive symptoms in the cohort), we examine the characteristics of the sample at Wave 2 and the frequency of depressive symptoms over time (at Wave 3) by migration status (using χ^2 and t-tests in bivariate analyses).

2.3.2. Analyses of migration selection

To achieve the second objective (investigating migration selection), we employ logistic regression analyses to estimate the probability of being a migrant away from the Agincourt study site as of Wave 3 (Hosmer Jr. et al., 2013). In Model 1 we contrast Wave 3 migrants with Wave 3 Agincourt study site residents (based on the full analytic sample). In Model 2, we predict the probability of being a Wave 3 migrant conditional on being a Wave 2 Agincourt study site resident, contrasting new Wave 3 migrants with Wave 3 Agincourt study site residents. We include in these analyses the set of sociodemographic and health status variables measured at Wave 2 that may be associated with migration status at Wave 3, including Wave 2 CES-D scores. Given the large number of participants with CES-D scores of zero, we include Wave 2 zero scores as a distinct category to differentiate those whose cumulative responses place them at the extreme low end of the scale (no symptoms) from those with higher scores (numbers of symptoms at greater severity).

2.3.3. Analyses of depressive symptoms

To pursue our third objective (examining the relationship between migration status and depressive symptoms), we fit a series of generalized linear models (GLM) using an inverse Gaussian (gamma family)-log link function. This specification is appropriate for modelling the outcome, CES-D scores at Wave 3, since the distribution is non-negative and positively skewed (McCullagh and Nelder, 1989).

Covariates age, gender, education, social support and diagnosis of a chronic condition are included in the models at Wave 3 values, since these reflect characteristics or conditions determined prior to the CES-D measure captured at time of survey, and we want more proximal measures of these variables to relate to the outcome. For migration and employment status, which are neither time invariant nor cumulative over time, we derive a set of categories to account for a potential change between Wave 2 and Wave 3 on depressive symptoms. For the migration status predictors, we contrast (1) continuing Agincourt residents (those who were living in the study site in Wave 2 and Wave 3); (2) continuing migrants (those who were living in migrant destinations outside of the study site in Wave 2 and Wave 3); (3) new migrants (those who moved out of the study site between Wave 2 and Wave 3); and (4) return migrants (those who returned to living within the study site between Wave 2 and Wave 3). To explore a potential effect of change in employment status between Wave 2 and Wave 3 we contrast participants who were continuously employed in Wave 2 and Wave 3, with those who were continuously unemployed (or not in the labour force) in Wave 2 and Wave 3, with those who gained employment (shifted from unemployed to employed between Wave 2 and Wave 3), with those who lost employment between Wave 2 and Wave 3.

For the GLM models, we progressively add sets of covariates to estimate three models. Model 1 reflects the effect of migration status (alone) on CES-D score since this is our exposure of interest. Model 2 adds predetermined sociodemographic characteristics age, gender and education. Model 3 includes controls for employment status and health and well-being characteristics (diagnosis of a chronic condition, social support and CES-D score at Wave 2 to control for a prior status along the scale of depressive symptoms). All models include controls for fieldworker effects acknowledging well-established evidence that some variation may exist between fieldworkers particularly on subjective survey questions (Cleary et al., 1981; McBee and Justice, 1977; Pollner, 1998).

This set of models is then reproduced with an alternative migration definition to incorporate a destination component. Here we contrast migrants who moved locally (to other destinations within the Mpumalanga Province but outside of the Agincourt study area), with those who moved to destinations in the mostly urban Gauteng Province, and those who moved to other provinces beyond Gauteng and Mpumalanga. We examined this alternative operationalisation of migration as destination to test for differences in depressive symptoms among urban dwellers or those further away from home. We present all statistical models making use of post-survey weights to adjust for sample loss. These results are consistent with unweighted analyses.

In addition to the models presented, we examined alternative specifications of the models in relation to the treatment of CES-D outcomes. We explored a set of models using the dichotomous CES-D score with a cut-off of 12 employed for clinically significant depressive symptoms (in line with validation studies of the CES-D instrument in South African populations (Baron et al., 2017)). We also used generalized ordinal logit estimation procedures to analyse CES-D scores as a set of ordinal response categories, with the proportional odds assumption met for many covariates, yet still more voluminous. Results were broadly consistent with the current models, which we present as both parsimonious and substantively clearer, retaining full information on the CES-D score. We examined, in addition to the above operanalizations of migration, a set of models where we use a binary variable for migration status (simply contrasting migrants with Agincourt residents). The effect of migration was in line with what we observed in the models reported – reducing in significance with the introduction of additional explanatory variables in the models. We further explored controls in the models for duration that a migrant was living in the destination (migration experience) and we found no significant effect. All statistical analyses were performed using Stata version 17.0 (StataCorp, 2023).

3. Results

3.1. Descriptive results

Table 1 displays the characteristics of the cohort at the study's Wave 2 survey, by migration status. At the time of this interview, 47.2% of the cohort were resident within the Agincourt study site, and 52.8% of the cohort were living in destinations away from their origin households. Of the latter, 45.7% had migrated to destinations within the Gauteng Province, while 42% of migrants had moved to less distant locations within the Mpumalanga Province (within which the Agincourt study site is located). A larger proportion of Agincourt residents compared to migrants were under 25 years of age in Wave 2 (25.9% compared with 21.2% of migrants), while most migrants were aged between 25 and 35 years (59.5%). A larger proportion of migrants were men (57.7%). The majority of migrants had completed high school or attained a post-secondary school qualification (76.9%), and 61.5% of migrants were employed at the time of the interview in contrast with 27.8% of Agincourt study site residents. A significantly smaller proportion of migrants compared with Agincourt residents reported a chronic condition diagnosis in the second study wave (6.6% of migrants and 15.4% of Agincourt residents, $p < 0.001$).

We find systematically low reporting on the CES-D in this population. Fig. 1 depicts the distribution of CES-D scores by migrant status for the terminal interval time point of Wave 3. Agincourt residents report significantly higher mean CES-D scores (2.49) than migrants (2.03), a differential that held as well in Wave 2 (1.34 vs 0.75 – see Table 1), with both groups moving upward measurably over the interval.

3.2. Migration selection models

Table 2 presents the results of the logistic regression models with outcome migration status at Wave 3. In Model 1, based on the full analytic sample ($n = 2951$), the CES-D variables in the model are jointly significant in predicting migration status at Wave 3 ($\chi^2_{(2)} = 13.40$, $p < 0.01$). Those with CES-D score of zero have 1.49 times the odds of those with CES-D scores above zero of being a migrant at Wave 3 ($p < 0.01$); however, the continuous CES-D score at Wave 2 does not add significantly to predictive power for migration status at Wave 3. Age group is not significant in predicting Wave 3 migration status, while men have 1.35 times the odds of women of having moved from the study site by Wave 3 (CI: 1.15 1.59). Those with at least a high school certificate have 2.21 times the odds of those with less education of having migrated by Wave 3 (CI: 1.86 2.62). Employment status at Wave 2 is also significantly associated with Wave 3 migration status (the group of employment status variables having a significant effect on the outcome, $\chi^2_{(2)} = 189.13$, $p < 0.001$). Those who were employed or not in the labour force (not looking for work) have 3.52 (CI: 2.94 4.22) and 1.79 (CI: 1.38 2.31) times the odds of unemployed cohort members of being a migrant at Wave 3. The odds of living outside of the study site at Wave 3 are 0.56 (CI: 0.42 0.74) times lower among participants who reported having been diagnosed with a chronic condition by Wave 2, a notable deterrent, in contrast with participants with no such diagnosis.

In the restricted sample (Model 2, $n = 1393$), CES-D score variables are not significant in predicting a new migration between Wave 2 and Wave 3, although in this less-powered model the direction of effect remains the same as in Model 1. Men are 49% more likely to undertake a new migration compared with women (CI: 1.03 2.15). A new migration is 59% (CI: 0.23 0.74) less likely among the oldest participants (36- to 44-year-olds) compared to participants aged 18–24 years. Education, employment and a chronic condition diagnosis are not significant determinants of a new migration in this period.

Table 1
Characteristics of the MHFUS cohort at Wave 2.

		Total cohort (n = 2967)		Agincourt resident (n = 1399, 47.2%)		Migrant (n = 1568, 52.8%)		p-value
		n	%	n	%	n	%	
Age group	18–24	695	23.4%	362	25.9%	333	21.2%	p < 0.01
	25–30	1006	33.9%	431	30.8%	575	36.7%	
	31–35	696	23.5%	338	24.2%	358	22.8%	
	36–44	570	19.2%	268	19.2%	302	19.3%	
Sex	Male	1493	50.3%	589	42.1%	904	57.7%	p < 0.001
	Female	1474	49.7%	810	57.9%	664	42.3%	
Education status	Primary school or lower	119	4.0%	91	6.5%	28	1.8%	p < 0.001
	High school incomplete	897	30.2%	566	40.5%	331	21.1%	
	Completed high school or post school	1945	65.6%	739	52.8%	1206	76.9%	
	Missing	6	0.2%	3	0.2%	3	0.2%	
Employment status	Not in labour force	348	11.7%	179	12.8%	169	10.8%	p < 0.001
	Unemployed	1259	42.4%	829	59.3%	430	27.4%	
	Employed	1353	45.6%	389	27.8%	964	61.5%	
	Missing	7	0.2%	2	0.1%	5	0.3%	
Chronic condition diagnosis	Yes	319	10.8%	215	15.4%	104	6.6%	p < 0.001
	No	2646	89.2%	1183	84.6%	1463	93.3%	
	Missing	2	0.1%	1	0.1%	1	0.1%	
Social support score	Mean (SD)	34.3 (7.0)		34.2 (7.1)		34.5 (6.8)		NS
	Min, Max	11, 44		11, 44		11, 44		
CES-D score (9-item)	Mean (SD)	1.0 (2.3)		1.3 (2.6)		0.7 (1.9)		p < 0.001
	Min, Max	0, 20		0, 20		0, 16		
Province of residence	Mpumalanga	2057	69.3%	1399	100%	658	42.0%	n/a
	Gauteng	717	24.2%	~	~	717	45.7%	
	Limpopo	93	3.1%	~	~	93	5.9%	
	North West	54	1.8%	~	~	54	3.4%	
	Other	46	1.6%	~	~	46	2.9%	

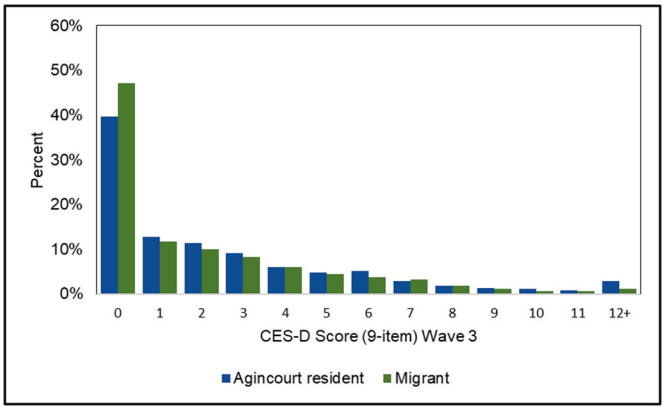


Fig. 1. Distribution of CES-D score (9-item) by migrant status Waves 3 Agincourt resident n = 1431 Mean = 2.49 Migrant n = 1533 Mean = 2.03 p < 0.0001.

3.3. Models of depressive symptoms (CES-D)

Table 3 turns to the follow-up assessment of CES-D 9-item scores at Wave 3, successively including three sets of covariates. Beginning with migration status variables, our exposure of interest, Model 1 shows that in contrast with continuing Agincourt study site residents, continuing migrants between Waves 2 and 3 have significantly lower CES-D scores (exp(coeff) = 0.84, CI: 0.75 0.94).

Adding predetermined sociodemographic variables age, gender and education (Model 2), the significant association for continuing migrant status is reduced (exp(coeff) = 0.90, CI: 0.80 1.01) while having at least a high school completion is associated with lower CES-D scores (exp (coeff) = 0.80, CI: 0.72 0.90). In Model 3, employment status change and measures of health and well-being are included. In contrast with the reference category of being continuously unemployed, being continuously employed between Waves 2 and 3 is associated with lower CES-D scores (exp(coeff) = 0.85, CI: 0.73 0.98). The association between completed schooling or tertiary education and lower CES-D scores remains statistically significant in this model (exp(coeff) = 0.89, CI: 0.79 0.99). Having a higher score on social support is associated with fewer depressive symptoms (exp(coeff) = 0.98, CI: 0.97 0.99), while suffering from a chronic condition is associated with higher CES-D scores (exp (coeff) = 1.34, CI: 1.16 1.56). Controlling for Wave 2 CES-D scores, we observe some continuity in CES-D measures over time for participants with higher risk of depressive symptoms (exp(coeff) = 1.03, CI: 1.01 1.05). A comparison of the three models based on the AIC and BIC values suggests that Model 3 is preferred. The predicted CES-D scores based on this model range from 0.80 to 7.49 with a mean of 2.28 which correlates positively with the observed mean CES-D scores (r = 0.24).

A companion set of models for CES-D outcome, with a more detailed indicator of migration destination for the migration status Wave 2 to Wave 3 variables, is displayed in Table 4. Model 1 shows an overall significant effect of migration destination variables on CES-D scores at Wave 3 ($\chi^2_{(3)} = 12.86$, $p < 0.01$). Participants who migrated to other areas within the Mpumalanga Province, or those who moved to the more urbanised Gauteng Province both have lower CES-D scores compared to those who remained in the area of origin (exp(coeff) = 0.86, CI: 0.75 0.98 and 0.85, CI: 0.75 0.98). Even fewer depressive symptoms were reported among participants who relocated to other provinces beyond the Agincourt study site (generally less geographically connected) (exp (coeff) = 0.70, CI: 0.53 0.90). This relationship is weakened once predetermined sociodemographic factors age, gender and education are included (Model 2). As with the prior set of models, the inclusion of employment status change and measures of health and well-being in Model 3 further reduces the significance of the "migration destination" coefficients. The coefficients in Model 3 are consistent with results reported in Table 3 indicating a significant relationship between

Table 2
Logistic regression models – outcome migrant status Wave 3.

Reference category: Agincourt residents		Model 1: Migrants Wave 3		Model 2: New migrants Wave 3	
		OR	95% CI	OR	95% CI
Age group	18-24 (Ref)	~	~	~	~
	25–30	1.25	(0.99 1.56)	0.81	(0.53 1.23)
	31–35	1.08	(0.85 1.38)	0.55*	(0.33 0.89)
	36–44	1.16	(0.89 1.51)	0.41**	(0.23 0.74)
Sex	Male	1.35***	(1.15 1.59)	1.49*	(1.03 2.15)
	Female (Ref)	~	~	~	~
Education status Wave 2	Incomplete high school or lower (Ref)	~	~	~	~
	Completed high school or post school	2.21***	(1.86 2.62)	1.30	(0.91 1.88)
Employment status Wave 2	Unemployed (Ref)	~	~	~	~
	Employed	3.52***	(2.94 4.22)	1.43	(0.96 2.14)
	Unemployed not looking for work	1.79***	(1.38 2.31)	1.28	(0.76 2.17)
CES-D score (9-item) Wave 2	Continuous	1.02	(0.97 1.08)	1.08	(0.99 1.16)
CES-D score of zero at Wave 2	Yes	1.49**	(1.17 1.91)	1.55	(0.96 2.49)
	No (Ref)	~	~	~	~
Chronic condition diagnosis Wave 2	Yes	0.56***	(0.42 0.74)	0.82	(0.46 1.47)
	No (Ref)	~	~	~	~
Constant		0.20***	(0.14 0.27)	0.08***	(0.04 0.14)
		N observations 2951		N observations 1393	
		Pseudo $R^2 = 0.1154$		Pseudo $R^2 = 0.0332$	
		Wald Chi ^{2} 386.77		Wald Chi ^{2} 31.19	

***p < 0.001, **p < 0.01, *p < 0.05, weighted models.

Table 3
Generalized linear models – outcome CES-D score (9-item) Wave 3.

		Model 1		Model 2		Model 3	
		Exp (Coeff)	95% CI	Exp (Coeff)	95% CI	Exp (Coeff)	95% CI
Migrant status Wave 2 to Wave 3	Continuing Agincourt resident (Ref)	~	~	~	~	~	~
	Continuing migrant	0.84**	(0.75 0.94)	0.90^{+}	(0.80 1.01)	0.95	(0.84 1.07)
	New migrant	0.84	(0.66 1.06)	0.85	[0.67 1.08)	0.85	(0.67 1.08)
	Return migrant	1.00	(0.80 1.24)	1.05	(0.84 1.30)	1.00	(0.80 1.24)
Age group	18-24 (Ref)	~	~	~	~	~	~
	25–30			0.95	(0.82 1.11)	0.98	(0.83 1.14)
	31–35			1.03	(0.88 1.21)	1.01	(0.86 1.19)
	36–44			0.93	(0.79 1.09)	0.87	[0.73 1.04)
Sex	Male	~	~	0.93	(0.84 1.04)	1.00	(0.90 1.12)
	Female (Ref)			~	~	~	~
Education status Wave 3	Incomplete high school or lower (Ref)	~	~	~	~	~	~
	Completed high school or post school			0.80***	(0.72 0.90)	0.89*	(0.79 0.99)
Employment status Wave 2 to Wave 3	Always unemployed (Ref)	~	~	~	~	~	~
	Always employed					0.85*	(0.73 0.98)
	Gained employment					0.92	(0.77 1.11)
	Lost employment					1.12	(0.94 1.33)
Social support score Wave 3		~	~	~	~	0.98***	(0.97 0.99)
Chronic condition diagnosis Wave 3	Yes	~	~	~	~	1.34***	(1.16 1.56)
	No (Ref)					~	~
CES-D score (9-item) Wave 2		~	~	~	~	1.03**	(1.01 1.05)
N observations		2964		2964		2958	
AIC		12515.9		12483.2		12314.0	
BIC		12563.8		12561.1		12427.8	

***p < 0.001, **p < 0.01, *p < 0.05,+p < 0.10.
Weighted, models control for fieldworker effects.
Modest changes in sample size across Models 1–3 are due to some missing values on independent variables.

Table 4
Generalized linear models – outcomes CES-D score (9-item) Wave 3, expanded migration status.

		Model 1		Model 2		Model 3	
		Exp (Coeff)	95% CI	Exp (Coeff)	95% CI	Exp (Coeff)	95% CI
Migrant Destination Wave 3	Agincourt study site (Ref)	~	~	~	~	~	~
	Other Mpumalanga	0.86*	(0.75 0.98)]	0.90	(0.78 1.03)	0.96	[0.83 1.10)
	Gauteng	0.85*	(0.75 0.98)	0.91	(0.79 1.05)	0.96	(0.83 1.11)
	Beyond	0.70**	(0.53 0.90)	0.75*	(0.57 0.98)	0.78^{+}	[0.61 1.01)
Age group	18-24 (Ref)	~	~	~	~	~	~
	25–30			0.96	(0.82 1.11)	0.97	(0.83 1.14)
	31–35			1.03	[0.88 1.20)	1.00	(0.85 1.19)
	36–44			0.93	(0.78 1.09)	0.87	(0.73 1.04)
Sex	Male	~	~	0.93	(0.84 1.04)	1.00	(0.89 1.12)
	Female (Ref)			~	~	~	~
Education status Wave 3	Incomplete high school or lower (Ref)	~	~	~	~	~	~
	Completed high school or post school			0.81***	(0.72 0.91)	0.89*	(0.79 1.00)
Employment status Wave 2 to Wave 3	Always unemployed (Ref)	~	~	~	~	~	~
	Always employed					0.85*	(0.74 0.98)
	Gained employment					0.92	(0.77 1.11)
	Lost employment					1.12	(0.95 1.33)
Social support score Wave 3		~	~	~	~	0.98***	(0.97 0.99)
Chronic condition diagnosis Wave 3	Yes	~	~	~	~	1.33***	(1.15 1.55)
	No (Ref)					~	~
CES-D score (9-item) Wave 2		~	~	~	~	1.03**	(1.01 1.05)
N observations		2964		2964		2958	
AIC		12507.7		12477.3		12308.5	
BIC		12555.7		12555.3		12422.4	

***p < 0.001, **p < 0.01, *p < 0.05,+p < 0.10.
Weighted, models control for fieldworker effects.
Modest changes in sample size across Models 1–3 are due to some missing values on independent variables.

completed schooling or higher education, continuous employment, social support and health status on CES-D scores. Model 3, the preferred model in terms of AIC and BIC values, predicts CES-D 9-item scores in the range 0.74 and 7.50, correlating with observed scores (r = 0.24). The more geographically nuanced models are broadly indicative of greater selectivity among migrants undertaking a move to more remote destinations but show little difference in other model coefficients in Table 3.

4. Discussion

South Africa presents a complex setting in which intersecting economic, social and environmental conditions have the potential to greatly influence the country's mental health burden. This study seeks to extend our understanding of these dimensions, and in particular, redress the sparseness of evidence on internal migration and depression in the country. Using cohort data for a young adult population from two time points, the likelihood of experiencing depressive symptoms in the cohort is ascertained, and the migration and depression relationship explored from two perspectives – the first examining depressive symptoms as a determinant of migration and the second, investigating the relationship between migration status and depressive symptoms – accounting for temporal sequence. The unique study design allows for a comparison between migrants and those who remain in a place of origin, shedding light on selection and health in a dynamic LMIC setting.

Our study finds comparatively low likelihood of experiencing depressive symptoms using a 9-item CES-D score in this young adult population. While the age ranges and samples are not directly comparable, these are in contrast (even if roughly adjusted for number of items) with other studies based on South African adults where higher average CES-D scores of 5.8 (Kim et al., 2022) and 6.9 (in a nationally representative sample) (Myroniuk et al., 2022) were observed. Average scores differ cross-sectionally by migrant status, with Agincourt residents (at Wave 2 and 3) having higher average CES-D scores than migrants. Extant literature finds diverse patterns of association between migration and mental health. The Migration and Health in Malawi study, for example, finds no significant association between general mental health status of migrants and non-migrants in the cohort following a move (Anglewicz et al., 2017), while an analysis of CES-D 10 scores based on national-level longitudinal data from the South African National Income Dynamics Study (NIDS), contrasting internal migrants and non-migrants at destinations, finds that the association differs at different survey time points (Ajaero et al., 2017). In line with our cross-sectional findings showing lower levels of depressive symptoms among migrants, a recent analysis of four waves of the NIDS data finds an improvement (via CES-D measurement) in emotional well-being following migration (Myroniuk et al., 2022). We observe a uniform increase in CES-D scores between Wave 2 and Wave 3 which is suggestive of a possible universal effect of the COVID-19 pandemic which overlapped with the interview at Wave 3 (see Ginsburg et al., 2022 for more details on the impact of COVID-19 on the cohort). This corresponds with findings from a systematic review of international literature identifying increases in depressive symptoms as a consequence of the COVID-19 pandemic (Vindegaard and Benros, 2020), and local studies noting an increased risk of depression during the COVID-19 pandemic period (de Kadt et al., 2021; Hunt et al., 2021).

We do not find consistent evidence of positive or negative selection on depressive symptoms in our analysis. While no significant selection effect is observed among those initiating a new migration between the two time points analysed, having a CES-D score above zero is associated with lower odds of being a migrant at Wave 3 (having migrated between Wave 2 and Wave 3 or at an earlier time). This contrasts with studies of internal migration that have associated migration with stress and psychological distress (Chen, 2011; Lu, 2010b) – migrants in this study, who are also more likely to be employed and have higher levels of education than those who do not move, have relatively low levels depressive symptoms. It is noteworthy that Agincourt residents have a higher likelihood than migrants of suffering from a chronic condition, and the presence of chronic conditions reduces the likelihood of migration. This

adds support to the healthy migrant hypothesis which, commonly studied in relation to physical health (Anglewicz et al., 2017; Lu, 2008; Lu and Qin, 2014), has been less studied in relation to mental health.

Our analysis of depressive symptoms shows that being a continuing migrant over the analysis period is associated with lower CES-D scores, although this relationship is no longer observed once employment status and health characteristics are introduced. Our results support trends observed in other studies of the socioeconomic determinants of mental health. We observe a positive association between educational attainment and mental well-being that has been observed in other South African studies (Hamad et al., 2008; Mungai and Bayat, 2019). We further find an association between continuous employment and lower CES-D scores in this young adult cohort. The link between lower socioeconomic status and increased depressive symptoms has been well established in the South African literature (Ardington and Case, 2010; Hamad et al., 2008; Lund and Cois, 2018). Migration, which is itself associated with education and employment, is likely to be an important variable interwoven along the causal pathway when examining the social determinants of mental health. In furtherance of this effort to disentangle migratory behaviour and reported health conditions, a noteworthy contribution of our study is that it considers *change* in migration status and employment in relation to the CES-D outcome, thus adding evidence around temporal ordering that goes beyond cross-sectional associations and doing so for a particularly relevant migration setting and population. Our expanded analysis incorporating migrant's destination into our migration definition indicates that the distance travelled, or characteristics associated with the destination location, may be associated with CES-D scores. Regional variation in the prevalence of depressive symptoms has been observed in other South African studies, with differences posited to relate to levels of poverty or the co-existence of other morbidities (Craig et al., 2022; Cuadros et al., 2019; Mkhize and Hamann, 2022).

The connection between physical health and depressive symptoms is underscored in our models with higher CES-D scores among those reporting a diagnosis of a chronic condition. We further find that social support is associated with lower CES-D scores in the cohort which echoes findings from other studies on the importance of social networks in the context of migration and more broadly (Berkman and Krishna, 2014; Lu, 2010a). It is noteworthy that we do not find significant gender differences in our analysis of depressive symptoms, as have been observed in several studies of mental health in low-resource settings including South Africa where women have a higher prevalence of depressive symptoms than men (Ajaero et al., 2017; Das et al., 2012; Lu, 2010a; Mungai and Bayat, 2019). We have found important gender differentials in the migration and physical health relationship based on MHFUS data (Pheiffer et al., 2023), and further qualitative research is planned to study women's mental and physical health and circumstances around migration.

Our study raises some important methodological considerations and potential limitations which are worthy of attention as this area of research develops. The questionnaire data and CES-D items were collected telephonically (using a translation of the English into xi-Tsonga). Research conducted in high-income, English speaking countries using telephone surveys have found little difference between telephone as a medium for collecting mental health measures compared with face-to-face interviews (Aneshensel et al., 1982; Rohde et al., 1997; Ryan et al., 2013). Moreover, telephone interviews, as our work has shown, can be conducted with less demand for resources than in-person interviews, and at more frequent intervals for focussed assessments on particular subjective conditions. Undoubtedly, further research would be valuable to investigate the use of telephone surveys of mental health indicators in LMIC and transition contexts. We propose that it may be challenging for fieldworkers to establish a high degree of rapport initially over the phone, and therefore participants may underreport their symptoms of depression. This is likely to compound issues around language-translation and cultural explanations of mental health symptoms in LMICs and diverse cultural settings. The development of culturally appropriate and validated measures for depression has been highlighted as an important area for further research in this specific study population (Adams et al., 2020) and more broadly (Close et al., 2016). Our experience underscores the need for robust training and validation of the CES-D instrument to account for items that may be potentially misunderstood in translation.

Our study, based on two time points, provides some insight into changes in mental health and corresponding migration trajectories. While in our selection model of new migrants, regressors are predetermined, we note the possibility in our CES-D outcome models of reverse causality given the close correspondence in time between the collection of our mental health outcome measure and the other covariates in our model. We reason that most covariates and changes in status between Wave 2 and Wave 3 would have taken place in advance of the CES-D survey that uses a one-week reference point prior to the interview. Accumulating longitudinal data on this cohort through repeated assessments of mental health status and corresponding migration trajectories over time will deepen our understanding of this increasingly important migration-depression relationship, particularly as the cohort ages and experiences further life cycle variation in socioeconomic conditions. Investigation of the complex role of migration on depressive symptoms may be expanded in future research on the cohort by considering more detailed circumstances (including household-level factors at origin, family dynamics and responsibilities, and social networks at origin and destination).

5. Conclusion

Migration is understood as a selective process, often undertaken by the most healthy, while disruption associated with relocation raises concerns of potential negative mental health impacts. In our study of a South African rural origin young adult population —incorporating a longitudinal design for including and retaining migrants— we add to the sparse evidence base on migration and mental health in LMICs. We find no evidence of selection on mental health among those initiating migration; however young adult migrants display fewer depressive symptoms than those who stay behind. Further, being employed, having higher levels of education and being in better physical health are protective against depressive symptoms. In South Africa, where internal migration is an important strategy to gain access to the labour market, efforts to support maintaining migrants' health, both physical and mental, is warranted. Attention need also be paid to those who may be less able to migrate (due to physical and possibly mental health conditions) and in turn, less likely to be economically engaged leading to greater vulnerability. Further examination of the role of migration, along with continuing attention to psychosocial measurement considerations for LMIC subpopulations, can improve our understanding of risk factors for mental health conditions.

Ethics approval and consent to participate

The Migrant Health Follow-Up Study was reviewed and approved by the University of the Witwatersrand Human Research Ethics Committee (Medical) (clearance certificate numbers M170277 and M220160), and the Mpumalanga Provincial Health Research and Ethics Committee. Informed consent for participation in the study was received in writing from all participants who were interviewed face-to-face. Informed consent was obtained verbally in Wave 1 in instances where migrant participants were not within reach for a face-to-face interview, and for Waves 2 and 3 where all interviews were administered via telephone. All methods were carried out in accordance with relevant guidelines and regulations.

Data availability

Data from the Migrant Health Follow-Up Study are available from the corresponding author on reasonable request. Agincourt Health and Demographic Surveillance Systems data are available through the SAPRIN URL <http://saprin.mrc.ac.za/>.

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CRediT authorship contribution statement

Carren Ginsburg: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tyler W. Myroniuk:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Chantel F. Pheiffer:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Bianca D. Moffett:** Writing – review & editing, Writing – original draft. **Michael J. White:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviations

CES-D	Center for Epidemiological Studies Depression Scale
CI	Confidence interval
COVID-19	Coronavirus Disease of 2019
GBD	Global Burden of Disease study
GLM	Generalized linear model
HDSS	Health and Demographic Surveillance System
HIV	Human immunodeficiency virus
LMIC	Low- and middle-income country
MHFUS	Migrant Health Follow-Up Study
NIDS	South African National Income Dynamics Study
NS	Not significant
OR	Odds ratio
TB	Tuberculosis

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmmh.2024.100330.

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