



Effects of Migration on Risky Sexual Behavior and HIV Acquisition in South Africa: A Systematic Review and Meta-analysis, 2000–2017

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Abstract

While human mobility has been implicated in fueling the HIV epidemic in South Africa, the link between migration and HIV has not been systematically reviewed and quantified. We conducted a systematic review of the role of migration in HIV risk acquisition and sexual behaviour based on 29 studies published between 2000 and 2017. Furthermore, we performed a meta-analysis of the association between migration and HIV risk acquisition in four of the studies that used HIV incidence as an outcome measure. The systematic review results show that HIV acquisition and risky sexual behavior were more prevalent among both male and female migrants compared to their non-migrant counterparts. The meta-analysis results demonstrate that migration was significantly associated with increased HIV acquisition risk (aOR = 1.69, 95% CI 1.33–2.14; $I^2 = 35.0\%$). There is an urgent need for effective combination HIV prevention strategies (comprising biomedical, behavioral and structural interventions) that target migrant populations.

Keywords Risky sexual behaviour · Multiple sexual partnerships · Risk of HIV acquisition · Migration · Meta-analysis

Introduction

Migrants are among the latest sub-groups to be classified as an HIV ‘key population’, being acknowledged as epidemiologically carrying increased risk, vulnerability and burden of infection due to a combination of biological, socio-economic and structural factors [1]. While HIV prevalence is 18.9% among the general population in South Africa, its concentration is characteristically higher in specific locations and sub-populations that are reported to practice high-risk behaviours [2]. Some rural communities, such as in KwaZulu-Natal (KZN) Province, are important socio-geographic settings for HIV outcomes, where adult migration rates are as high as 26% and HIV prevalence ~40% [3]. The exceptionally high prevalence of internal migration in South Africa (i.e. up to 42%) is rooted in apartheid era policies that were aimed at ensuring the supply of rural African male laborers in urban and industrial centers, such as Johannesburg [4, 5].

Existing literature on the link between migration and HIV discuss the importance of the social and political-economic context of risk, with migration and mobility playing a central role in the rapid spread of the epidemic in South Africa [6]. Historically, migration was a male domain that entailed the positive selection of prime-aged men (i.e. unmarried, or if married, often migrated without their wives and families),

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who left their rural communities for work [7–9]. Under these arrangements, migration fueled the epidemic [10], and facilitated temporal disengagement from the home region's sexual networks, thereby creating a demand for new sexual networks in the urban destination, where there is greater occurrence of risky sexual behavior that has been linked to HIV transmission [11–13]. In a Gauteng Province study, migrant men were more likely to engage in risky sexual behaviours, such as having unprotected sex (83%) and casual sex partners (93%), than non-migrant men [14]. More recently after 2000, it has been demonstrated that a large increase in internal female migration [15, 16], often associated with more frequent trips over shorter distances than the male migration [9, 10], may contribute to the persistent HIV epidemic. Women tend to migrate for purposes of employment and often access seasonal and low-paying informal jobs (e.g. domestic work, informal selling and trade) [17], being thus at risk of turning to transactional sex, either as a primary/secondary livelihood strategy [18, 19].

Despite the evidence indicated above, little is known about the pathways linking migration and HIV transmission in sub-Saharan Africa [20]. The link between labour migration and HIV is illustrated by Weine and Kashuba [21], who showed that, across diverse global locations (i.e. Africa, the Americas, Europe, South East Asia and Western Pacific), increased HIV risk was associated with sexual practice determinants, such as low condom use, multiple partnering and lack of HIV knowledge. However, they have not reported on female migrants engaging in commercial sex work (i.e. with a large number of partners) and other mobile populations groups, such as refugees and/or asylum seekers. Moreover, their review featured results from only seven of the 97 South African studies that address HIV risk among labour migrants despite evidence that the country contains more than 19% of the world's HIV-positive population [1]. This potentially underrepresented data from the largest epidemic in the world and region with higher than average prevalence of migration.

This paper therefore summarized the South African literature since there is no evidence of systematic review reports on migration and HIV risk. It attempts to address this issue through a collation of the demographic and behavioral health-science literature, and examines the relationship between measures of migration, HIV risk behaviours and infection. Given that HIV prevention strategies are tailored to maximize condom use, and that voluntary counselling and testing services for migrant populations are unavailable [22], the objective of this review is to more fully understand the complex relationship between mobility, risky sexual practices and HIV acquisition. This necessitated examining the various definitions of migration, and summarizing the key findings, predictors of HIV infection, risky sexual behavior and biological outcomes of HIV in the studies included. Our

undertaking here may provide important evidence to support the development of effective prevention programs for this vulnerable population.

Methods

Study Eligibility

The review spans work published from 2000 to 2017, with the selection following the Population, Intervention, Comparative group, Outcomes, Study design (PICOS) criteria for systematic reviews [23], the inclusion criteria being empirical studies conducted in South Africa examining HIV and migration. Specifically, those reporting data on HIV risk factors, prevalent and incident HIV infection linked to migration.

Literature Searches

Systematic literature searches were performed on five academic databases, namely: PubMed Central, Sage Publications, Google Scholar, Web of Science and J-STOR, which identified over 4800 articles on South Africa. Title and abstract searches were conducted on relevant English studies between 2000 and 2017. This 17 year span marks an important period of HIV viral evolution [24] due to the improved ART coverage, and was associated with increased life expectancy, and a likely lowering of HIV risk perception in key populations [25].

Based on an initial scoping of the mobility and HIV-risk literature, the following query terms and phrases were included: HIV, AIDS, migrant, migrants, labour migrants, truck drivers, mobility and migration. Studies indexing the concept of mobility were identified by using the truncation 'migrat*' (exclusive to Web of Science and PubMed Central), returning results from multiple keyword variations such as; 'migration', 'migrancy', 'migrate' and 'migrant'. Building on this, the subject heading 'HIV risk behaviour' was added to the search, including terms synonymous with sexual behaviour, with implications for HIV transmission "sexual risk behaviour", "transmission risk", "multiple sexual partnerships", "AIDS risk behaviour" etc. We also explicitly examined incident infections by including common keywords, such as; "HIV infection", "HIV incidence", "new infections" "risk of HIV acquisition" etc. as detailed in Table 1. This demonstrated a composite filter process for our first round attempt at identifying the literature linking how aspects of migration intersect with HIV risk factors and outcomes.

Other study retrieval methods, while remaining secondary to the main searches above, were conducted to obtain additional literature, including hand-searches. This technique is

Table 1 Keywords for article search on Web of Science

Concept	Key search terms	Subject headings
Migration	("Labour migration" [MeSH Major Topic]) OR ("Migration*" [Title]) OR ("rural to urban migration [MeSH Major Topic]) OR ("temporary labour migration" [MeSH Major Topic]) OR ("circular migration" [Title]) OR ("oscillating migration" [MeSH]) OR ("mobility" [Title]) OR ("outmigration" [Mesh Major Topic]) OR ("non-residency" [Title]) OR ("Internal migrants" [MeSH Major Topic])	"Migration", "mobility", migrancy
HIV risk	HIV sexual behavior ("multiple sexual partners" [MeSH Major Topic]) OR ("HIV risk" [Title]) OR (HIV*[Title] OR "transmission risk") [Title] OR ("AIDS risky behavior" [MeSH Major Topic]) OR ("concurrent sexual partners" [MeSH Major Topic]) OR ("transactional sex" [MeSH Major Topic]) OR ("casual sex" [MESH Major Topic]) OR ("sex work" [MeSH Major Topic]) OR ("unprotected sex" [MeSH Major Topic]) OR ("anal sex" [Title])	"HIV/AIDS", "HIV risk", "risky sexual behavior"
	HIV infection ("HIV incidence*" [Title]) OR ("HIV infection*" [Title]) OR ("HIV AND (heterosexual transmission*" OR "risk of acquisition" OR "risk" OR "new infections" OR "sero-incidence" [MeSH Major Topic])	"HIV incidence", "HIV risk acquisition"

a purposive page-by-page examination of relevant journal issues, specific studies and conference proceedings [23]. Moreover, the 'cited by' reference-searching feature compliant with Web of Science (i.e. linking journal articles to other studies in which they have been cited) was used.

Table 1 details the final search query terms pertaining to the independent/explanatory variable 'migration' and the outcome of interest/dependent variable 'HIV risk', which, when combined with Boolean operators AND/OR within each concept (labour migration and HIV risk), identified an initial range of relevant study records. The database searches began in January 2017, with electronic, hand searching (i.e. searching through content of journal articles to identify relevant studies) and examining the results generated from the initial search, and concluded on 30 August, 2018. Notably, the database search (PubMed Central) returned 4887 hits, while 11 studies were obtained through hand searching. A total of 4898 records were retrieved, and after multiple iterations and search query refinement, title and abstract screening was performed on 71 full-text records that were extracted to Mendeley (v1.16.2. reference manager), based on their relevance to the scope of the review. However, a further 42 articles were discarded after failing to meet the inclusion criteria, which resulted in 29 studies being included, as presented in Fig. 1.

Data Extraction

The data from the 29 empirical studies (published between 2000 and 2017) selected for inclusion, after successive rounds of filtering, were retrieved and entered onto a

Microsoft Excel workbook. These studies comprised four longitudinal, 16 cross-sectional, five qualitative and five mixed-methods studies. Two independent reviewers, [i.e. a content and a method (systematic review) expert] conducted title-screening to verify which reports should be included in the final review. Queries regarding inclusion were resolved through consultation with the review team members. The Mixed Method Appraisal Tool (MMAT) was used to generate a score to measure the methodological quality of the studies and evidence reported to establish the risk of bias. Once consensus over the validity of study selection was reached, the following were explored: defining migration, identifying key conceptual frameworks and predictors of HIV infection, risky sexual behaviour and biological outcomes of HIV.

Meta-analysis

Data were analyzed using STATA version 15 (StataCorp, College Station, Texas, USA), with estimates of HIV acquisition risk and 95% confidence intervals (CI) of exposure-outcome pairs being presented on forest plots. These data were obtained from the studies that reported hazard ratio and 95% CI. I^2 statistics were used to measure the percentage of observed total variation across the studies due to heterogeneity rather than by sampling error [26, 27]. We made a prior decision to use a random-effects model for combined effects (given our assumption about anticipated variation among the studies), and presumed that the studies were conducted independently. In terms of potential publication bias arising from small-study effects, we did not construct funnel plots or test them for asymmetry,

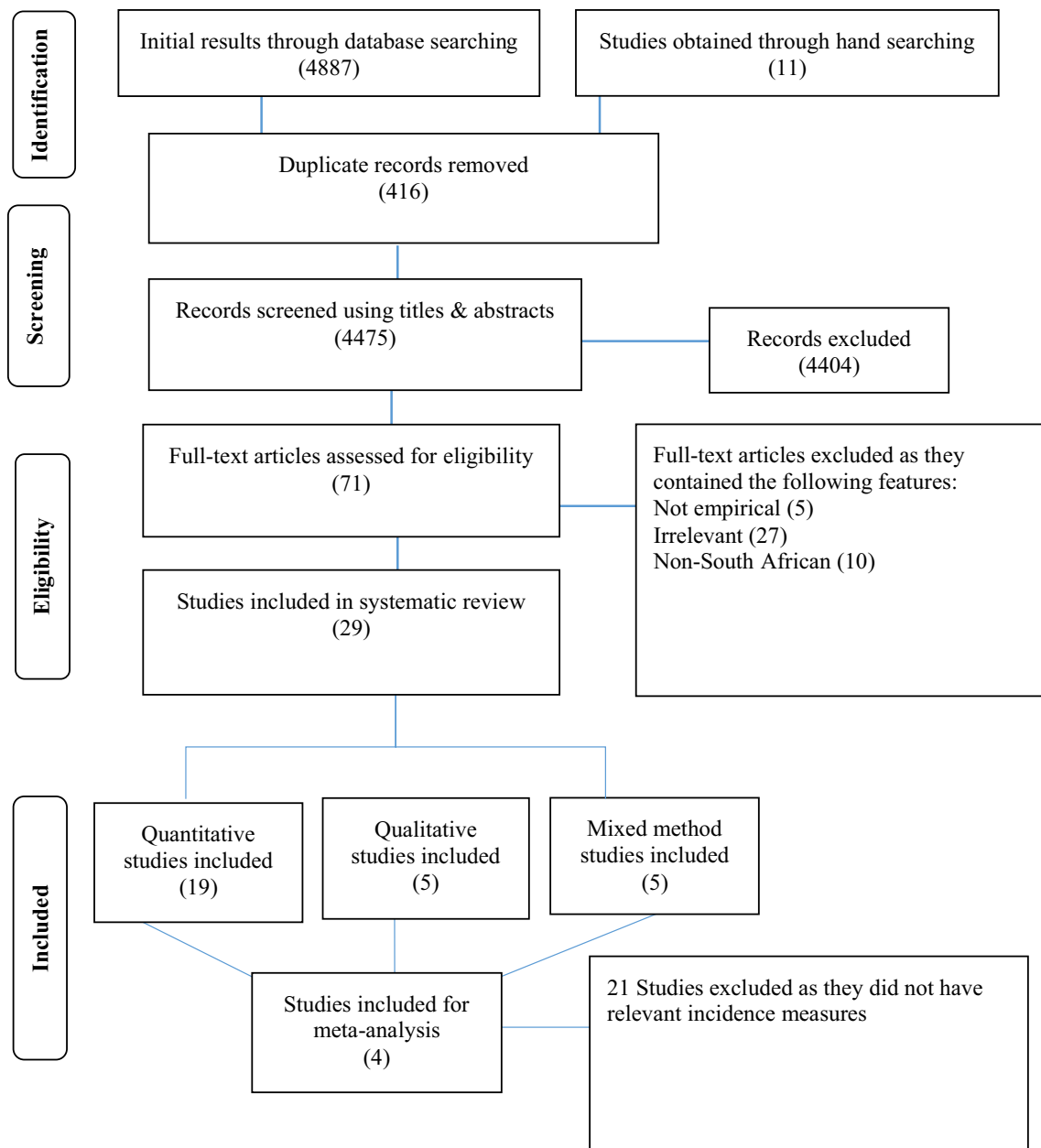


Fig. 1 Flow diagram of primary studies selected for systematic review of migration and effects on risky sexual behavior and HIV infection

given inadequate number of studies [28] (it is recommended to have a minimum of 10 studies). Due to the large variation in their sample sizes i.e. large population-based research versus small studies, we conducted a sensitivity analysis to examine the influence of each study on the overall meta-analysis summary estimate by omitting each study in turn.

Results

Defining Migration

Table 2 shows that while all of the studies offered definitions of migration, there were important differences among

Table 2 Definitions and of migration and HIV

Reference	Definition of migration	HIV outcome and findings overview
Sema-Baltazar et al. [33]	Mozambican men migrating yearly to South Africa to work in the mining sector, living away from their home and family members	Multiple partners (multiple spouses, transnational relations, and multiple occasional partnerships), inconsistent condom use, and a high proportion of infected mineworkers who do not know their HIV status increases the risk of HIV transmission in this sample
Barnighausen et al. [44]	Temporary migration spanning over two time-points; i.e. away from home and return to the study site	Various socio-economic status measures were significantly associated with risk of HIV acquisition. Migrants reported increased sexual risk behavior, such as multiple sexual partnering yet increased educational attainment lowered their risk of HIV acquisition
Camlin et al. [17]	Changes in residency determine migration events. These are classified as in-migrations (a migration into a homestead within the surveillance area), internal migrations (migrations within the surveillance area) or out-migrations (migration to a homestead outside of the area). Migrations are described as either being an individual or a household occurrence, with household migration involving a change of residence by all resident members of the household	Higher risk sexual behavior in the context of migration increased women's likelihood of HIV infection. Sexual risk behavior and the probability of HIV infection was gender sorted, for instance, increased lifetime partners, having additional sexual partners and odds of HIV infection were high in female migrants opposed to male migrants
Collinson [10]	Involves a household member who is away the majority of time, but retains a significant link to their base household and remains a household member while away. Temporary migration status is based on 'resident months' status which records the amount of time each person is physically present in the household during the year preceding the census interview	Migration is associated with HIV although the relationship is not linear. For instance, migrants returning home more may be less exposed to outside partners and therefore invoked less in the HIV epidemic
Collinson et al. [4]	A move made by a person during the inter-censal period (1991–2001) into the place where they were enumerated in the 2001 census	HIV is strongly linked with mobility; high levels of circular migration can lead to increased risk of multiple sexual partners at both ends of the migration cycle. This is coupled with low perception of personal risk, enabling conditions for the transmission of HIV
Dladla et al. [45]	Synonymous with labour migration to urban areas for extended periods of time, but with frequent return visits	HIV transmission may be bi-directional i.e. instead of solely accounting for the continued transmission of HIV to migrant men's sexual behavior, female partners left behind reported involvement in risk taking such as having additional sexual partnerships
Delany-Moretlwe et al. [42]	Occupational mobility i.e. long distance truck driving	Occupational mobility promotes ongoing HIV risk behavior as well as reducing access to health services, highlighting the need for enhanced industry-based targeted interventions for this population
Dobra et al. [3]	Migration objectively consists of various captured patterns of repeated movements inside and outside the study area, using detailed longitudinal data on the location and duration of absence of individuals outside their normal residence, and quantifying periodic changes of residences by measures such as time and distance	There is a clear nonlinear relationship between distance migrated and HIV acquisition. Accordingly, findings show that even considerably short-distance migration events confer substantial additional risk of acquisition
Gilgen et al. [14]	Living elsewhere in South Africa or in another country but working in Carletonville or Khutsong	Despite scale-up of health education programs mineworkers had a higher number of sexual partners and were using condoms less consistently with their casual sexual partners than men in townships surrounding mining centres, who were not exposed to repeated health education programs

Table 2 (continued)

Reference	Definition of migration	HIV outcome and findings overview
Giorgio et al. [18]	Men who were cross-border migrants between the ages of 18 and 54 and lived, worked or socialized in Cape Town or its surrounding suburbs	HIV prevalence was estimated to varied substantially by country of origin. Adjusting for country of origin, HIV sero-positivity associated with age, high school completion, not having enough money for food, alcohol use, and engaging in transactional sex
Hargreaves et al. [47]	Labour migration involves the movement of adult men and women residing away from home for more than 6 months per year	High HIV incidence rates and sexual behavioral patterns are mediated by socio-economic attributes, such as low education and temporary migrancy. Some risky sexual behaviours that include early sexual debut, having multiple sexual partners are on the increase among these individuals
Hunter [58]	Circulatory movements to urban destinations, particularly to extra-legal settlements (a migration stream increasingly featuring more women)	The rise of HIV is embedded in the increased movement of women after apartheid, necessitating new forms of dependence some women have on men. Informal settlements as major receiving regions for new migrants are associated with increased HIV infection rates, resulting in spatial health inequalities
Hunter [48]	Temporary labour movements to urban destination regions by prime-aged men and women	HIV/AIDS is rooted in the complex interplay of various socio-economic factors, such as increased unemployment, social inequalities and rising levels of women's migration, especially through circular movements between rural areas and informal settlements/urban areas, which are in turn becoming high risk settings
Kahn et al. [46]	A person is considered a temporary migrant if the months resident in the surveillance household (Agincount) number less than six, and if the respondent declares that the migrant retains strong links with the household	Negative consequences of migration such as increased behavior for the spread of HIV was common in men of certain socio-demographic profile. For example, men reporting two or more sexual partners were differentiated by work and migration status, employed migrants were commonly implicated
Lurie et al. [38]	Young men leaving their rural homes for work in urban areas; long-distance migration comprise of infrequent trips home and short-distance migration, more frequent trips home	Typical with the spread of other infectious diseases, HIV transmission follows the movement of people. Thus, migration was an independent risk factor for HIV infection among men
Meekers [36]	Involved migrant workers who are away from their homes and families for long periods of time	AIDS awareness programs implemented by the mining industry and the behaviour change communications of a condom social marketing campaign targeted miners and commercial sex workers in the mining communities are a likely cause for reduction in risky behavior
McGrath et al. [52]	'External migration' is defined as the migration of an individual or household within the DSA to a household outside the DSA; the proportion reported represents external migration in individuals who migrated at least once in the past 2 years (recent migrants)	Migration was associated with increased prevalence of sexual risk behaviours. Furthermore, former instead of recent migrants were more likely to be infected by HIV, suggesting prevalence of return migration to home regions to seek for care when ill
Munyewende et al. [30]	Migration is a livelihood strategy involving cross boarder movement of persons, and is increasingly linked with diminished access to health and high levels of HIV infection	The increased exposure of foreign female migrants to sexual violence escalates their odds of acquiring sexually transmitted infections (STIs), including HIV. Perceptions of relatively low HIV risk in addition complicated their uptake of prevention responses
Niehaus [37]	Mine work-induced migration mainly from homelands in the Eastern Cape but also involving transnational migrants from neighboring countries such as Mozambique	Residence single sex mining compounds for long created conditions conducive for risky sexual contact of miners such as multiple sexual partnering, visiting sex workers and sex with other men
Ramjee and Gouws [13]	Having traveled to provincial destinations in South Africa including travelling to neighboring countries during the course of work as a driver	Truck drivers may have facilitated the spread of HIV infection throughout southern Africa
Richter et al. [29]	Internal migration involves being born in different province from where one works, and cross-border migration consisted women born in another country	Study data illustrated the dominant economic dependence of migrants in sex work and the relative resilience of cross-border migrants in South Africa

Table 2 (continued)

Reference	Definition of migration	HIV outcome and findings overview
Richter et al. [43]	Movement into South Africa from elsewhere, or internal migration with women moving to the cities hosting 2010 soccer world cup matches	No increases were detected in indicators of sex work supply, including the proportion of sex workers newly arrived in the city (<2.5% in each phase) or those recently entering the trade ($\leq 1.5\%$)
Townsend et al. [31]	Foreign migrants are a category of persons who leave their home and travel to a new host country, where they tend to self-settle, as movement and access to employment opportunities are less restricted than in refugee camp settings	Considerably high HIV prevalence was associated with being a self-settled foreign migrant in Cape Town. Correlates of HIV infection included: older age, country of origin, being unmarried, having lived in South Africa for 3–5 years, sexual debut of ≥ 15 years and having used a condom at last sex
Slabbert et al. [50]	Women in Johannesburg migrating from Zimbabwe or other countries, often at a young age	Migrancy and mobility are an integral part of sex work in most settings, which undermines their contact with health providers
Vandormael et al. [34]	Individuals frequently change residency within the surveillance area and whose record of new exposure episodes was captured	In a context of increased use of ART-as-prevention individually, linking HIV-uninfected individuals to sexual partners outside the household is increasingly becoming difficult given that external migration of sexual partners outside of the study areas (such as surveillance areas)
Walker and Oliveira [32]	Participation in globalization through 'transnational migration', 'as members of the diaspora', 'as entrepreneurial women', 'as flexible workers', travel responses to vast structural pressures that push and pull them to sell sex	Being in Johannesburg, a city with the largest proportion of South Africa's migrants, female migrants resort to selling sex in face a number of vulnerabilities
Welz et al. [51]	Involves being mobile, classifiable as non-residence in the surveillance area	Several factors, including increased mobility, associated with an increased risk of HIV infection among residents, were also associated with non-participation in the study
Zuma et al. [39]	Commonly manifests as circular migration between rural and urban areas, whereby migrants maintain close links with their rural homes to which they return occasionally	Migration among other factors such as age and marital status, independently associated with HIV infection
Zuma et al. [40]	Circular migration in which young men migrate to work in urban areas, leaving behind their sexual partners, to whom they return periodically	Migration contributes significantly to the spread of STIs particularly HIV. Results show that migration status coupled with HIV status were important determinants of STIs

them. These included dimensions of mobility, including selectivity to migration (i.e. whether individuals had distinct characteristics suiting them to migrate), and migration stream (that migrants had a common origin and destination). Such studies used conventional demographic definitions of migration, such as ‘internal migration’, ‘temporary labour migration’ and ‘circular migration’, referring to migration within South Africa, where persons keep their contact with a rural homestead. Definitions further included immigration, in that migrant were referred to as: ‘foreign migrants’ or ‘external migrants’, ‘cross-border migrants’ and ‘transnational migration’ [29–33].

Nine of the 29 studies were conducted in demographic surveillance sites (DSS), either the Africa Centre Demographic Information System (ACDIS) or the Agincourt Demographic and Health Surveillance Site (ADHSS), respectively located in rural communities in KZN and Limpopo Provinces. They examine forms of mobility involving a change of residency, denoting migration events [34, 35]. Using residence history data, the DSS studies define in- and out-migration on the basis of residence change that consists of crossing the boundaries of the designated surveillance area [10], thusly classifying internal or external migrants. Conversely, other studies used the census definition that internal migrants cross geo-political boundaries, usually magisterial districts or provinces [14]. Migration for the purposes of labour or ‘occupational mobility’ featured prominently in the studies sampling mine workers [14, 36–40], truck drivers [41, 42] and migrant women who engage in sex-work in the destination and/or are mobile sex workers [29, 31, 32, 43].

Study Hypotheses and Key Messages

The studies reviewed diverse aspects of the migration-HIV link, which we summarized accordingly the various study objectives and key findings that indicated the mechanisms affecting this relationship (Table 2). Cohort prospective studies capturing individual sexual histories highlighted the impact of time-variant factors, such as income Adjusted Hazard Ratio (AHR) 0.93 (*s.e.* 0.0279) $p=0.022$ wealthier compared to poor and sex AHR 1.83 (*s.e.* 0.3616) $p=0.002$, on risk of HIV acquisition [44]. Other studies highlighted the socio-economic differences between the male migrants and non-migrants that were associated with risky sexual practices, such as having more than two lifetime sex partners [4, 39]. The main reasons why foreign migrant women who engage in sex work were implicated in HIV infection and risky behaviour relates to their very high exposure to structural and sexual violence, including poor access to local medical care and support service inequalities [31, 33]. In three studies, non-migrating spouses of male labour migrants

were included, with the hypothesis of a bi-directional stream of HIV transmission being emphasized [42, 45, 46].

Risky Sexual Behaviour

An array of self-reported sexual behaviour practices in both men and women in migration situations have implications for HIV infection (Table 3). Disaggregated by gender, migrant men, mainly those residing in single-sex settings, were more likely to engage in risky sexual behaviours, such as unprotected and anal sex, multiple partnering and visiting commercial sex workers. One study found that migrant men were 1.5 times more likely to have multiple sex partners compared to non-migrant men (95% CI 1.03–2.20) [47]. Other factors (i.e. attitudes) for increased HIV vulnerability included limited knowledge of HIV transmission and low self-assessment for HIV risk prevention [30].

Reported Condom Use

Migrants were less likely to report condom use compared to non-migrants in the included studies. This lower usage was more prominent when results were disaggregated by migrant origin, and whether before or after a behaviour intervention. Non-migrant women compared to migrant women were more likely to report condom use (OR 1.88, 95% CI 1.02–3.45) [39]. One study shows that male migrants compared to non-migrants were less likely to report condom use with regular sexual partner (10.9% vs. 23.7%, $p=0.04$). Foreign migrant women who engage in sex work in South Africa were less likely to use condoms compared to local migrant women for the same activities (90.6% vs. 94.5%, $p=0.08$) (see Table 4). Similarly, among South African women, migrants in sex work compared to non-migrants were less likely to report condom use with clients (94.5% vs. 89.1%, $p=0.02$) in the same study [43]. In 2000, a study comparing the prevalence of risky sexual practices among mineworkers between a pre- and post-HIV prevention campaign noted that condom use with spouse was 18% before and 26% after, and with other partners, 60% before and 67% after [36].

Multiple Partnering

Many studies reported higher rates of multiple partnering among migrants compared to non-migrants. Older, married, migrant men, sexually active young men under the age of 35 years, younger women, and resident women married to migrant men reported having additional sexual partners other than their spouse or main sexual partner [10, 33, 37, 45, 46, 48, 49]. On the other hand, being a non-migrant, shorter distance migration and returning home regularly was not associated with multiple partnering.

Table 3 Study characteristics and qualitative results

References	Title	Study location	Focus/aim of study	Socio-demo-graphic profile	Methodology	Sample size (by gender)	Age	Marital status	Migrant Sexual risk behaviors
Diadla et al. [45]	Speaking to rural women: the sexual partnerships of rural South African women whose partners are migrants	A rural district of uMkhanyakude District, in the (ACDIS) KwaZulu-Natal	To investigate and understand the sexual behaviors and different types of relationships female partners of migrants keep, and examine their behaviour in each relationship in terms of communication, commitment and condom use	Female partners of migrant men	Qualitative study design	Female ♀ = -	19–44 years	Married and/or in a sexual partnerships	Wives/partners of migrant had extra-marital sexual partnerships with male in-migrants. Ironically, these women felt at risk of HIV infection due to their partner's behavior and not necessarily their own. Men known to give females money were the most preferred casual partners. Correspondingly, having additional sexual partners was associated with the need for financial support i.e. transactional sex
Hunter [58]	Beyond the male-migrant: South Africa's long history of health geography and the contemporary AIDS pandemic	Mandeni Township KwaZulu-Natal	Trace the increased female labour mobility as it relates to the new forms of dependence some women have on men, and the rise of urban informal/shack settlements that are zones of the highest HIV rates in the South Africa.	Migrant women in an urban township in KZN	Mixed methods design	Female ♀ = ♀ = -	-	Single	Failure to secure employment in the urban destination region compels young migrant women to engage in current multiple sexual relationships, and some in transactional sex in order to diversify their income.

Table 3 (continued)

References	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age	Marital status	Migrant Sexual risk behaviors
Hunter [48]	The changing political economy of sex in South Africa: The significance of unemployment and inequalities to the scale of the AIDS pandemic	Isithebe Township in KwaZulu-Natal	Exploring the sexuality in the late apartheid and post-apartheid in the wake of growth of female circulatory migration whose base is a rural home	Women in a urban informal settlement in KZN	Qualitative study design	Female ♀ = -	-	Single	Young migrant women were involved in multiple-concurrent sexual partnerships (signifying multi-local sexual networking). Women reported having unprotected and transactional sex. Poor labour outcomes, i.e. securing menial employment (e.g. accruing about R50 per week) was associated with the sexual behavior outlined above

Table 3 (continued)

References	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age	Marital status	Migrant Sexual risk behaviors
Munyewende et al. [30]	Exploring perceptions of HIV risk and health service access among Zimbabwean migrant women in Johannesburg: A gap in health policy in South Africa	Johannesburg	Document the special characteristics of Zimbabwean female migrants, particularly examining their perceptions on HIV risk, and their experiences of health services in South Africa	Migrant women in inner city Johannesburg	Qualitative study design	15 (female ♀ = 15)	19–43 years	–	Female labour migrants exhibited relatively low perception of risk, this study reports reluctance test for HIV as they felt 'too healthy' to test, an attitude largely driven by a fear of receiving a positive test result. Limited condom use was very common, especially among those involved in street trading, citing, among other reasons, that sex with a condom loses its sensation and their use infers lack of trust between partners.

Table 3 (continued)

References	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age	Marital status	Migrant Sexual risk behaviors
Niehaus [37]	Renegotiating masculinity in the Lowveld: Narratives of male–male sex in compounds, prisons and at home	Impalahoek, a village in the Bushbuckridge area of the South African Lowveld.	Examine the experiences and recollections of male–male sex by former miners and prisoners in Impalahoek	Former migrant miners	Qualitative study design	♂ Male	–	–	Migrant mine workers engaged same-sex sexual contact with other younger miners in the absence of women. They largely perceived anal sex with men reduced chances of HIV infection. Older and wealthier miners would maintain multiple sexual relationships with other young co-workers ‘mine wives’ in exchange for gifts, money and favours at work
Walker and Oliveira [32]	Contested spaces: Exploring the intersections of migration, sex work and trafficking in South Africa	Hillbrow and Yeoville, Johannesburg, Limpopo province	Explore sex work and migration broadly and examine the specific practices and vulnerabilities faced by those who neither self-identify as sex workers nor align with the sex worker movement.	Female migrants who sell sex in Johannesburg	Qualitative study design	19 (female ♀ Male ♂ and transgender ♀♂)	≥ 18 years	–	Sex work is a viable option for many women confronted with other very limited choices and the need to survive in the city they moved to

A dash/hyphen (–) in a cell shows that response data on the variable described in subject are either missing or not reported. In this table above, marital status information and data for age categories of sampled migrants were in a few occasions unavailable

Table 4 Quantitative studies with sexual behaviour outcomes

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Baltazar et al. [33]	HIV Prevalence and Risk Behaviors Among Mozambicans Working in South African Mines	Border town between South Africa and Mozambique, Ressano Garcia	Estimate the prevalence of HIV and associated risk behaviors, and assess the use of and access to HIV prevention programs within this population	Mozambican men working in South African mines	Quantitative Cross-sectional design	430 (Male ♂ = 430)	23–68 years	Never married Married/cohabitating Widower/divorced/separated	Mozambican migrant men Mozambican migrant men	Female sex worker No condom at last sex 6.6% (4.2–8.9) 81.5% (77.8–85.2)
Camlin et al. [17]	Gender, migration and HIV in rural KwaZulu-Natal, South Africa	A rural district of uMkhanyakude district in northern KwaZulu-Natal	Examine whether the associations between migration differ for men and women so as to identify pathways through which women's migration contributes to their high infection risk.	Men and women from rural KZN	Quantitative Cross-sectional design	4731 Female ♀ = 3297 Male ♂ = 1432	15–54 years	Married and unmarried	Female migrant Male migrant Female migrant	Multiple sex partners Lifetime partners Lifetime partners 2.1. versus 1.9 (p<0.001)

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Collinson et al. [4]	Trends in internal labour migration from rural Limpopo Province, male risk behavior, and implications for the spread of HIV/AIDS in rural South Africa	Agincourt sub-district of the Bushbuckridge district in Mpumalanga province	Trends in internal labour migration, linkage with age, male risk behavior compared to resident men to examine the implications for the spread of HIV/AIDS in rural South Africa.	Labour migrant men in a rural area in Mpumalanga	Mixed methods design	11,977 (Male ϕ = 11,997)	20–49 years	Married and unmarried	Working Migrant men	Two or more sexual partners 50% versus 38%
Collinson [10]	Striving against adversity: the dynamics of migration, health and poverty in rural South Africa.	Agincourt sub-district of the Bushbuckridge district in Mpumalanga province	Assess the impact of migration on the socio-economic status of remaining households and the health outcomes (focusing on HIV) among migrants and their families	Migrant and non-migrant men in Agincourt, Mpumalanga	Quantitative Cross-sectional design	12,061	15–65 years	Married and unmarried	Male labour migrant	Multiple sexual partners 52% versus 44% (p=0.075)

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Delany-Moretlwe et al. [42]	HIV prevalence and risk in long-distance truck drivers in South Africa: a national cross-sectional survey	Long distance truck-stops in South Africa	Determine the prevalence of HIV, STIs, and associated risk behavior in long-distance truck drivers in South Africa.	Long-distance truckers, co-drivers or assistants	Quantitative cross-sectional design	1900 (Male ϕ = 1900)	18–71 years	Married living with spouse/sexual partner, Married living alone Unmarried living with sexual partner, Not married not living with sexual partner.	Truck driver Truck driver Truck driver	Concurrent sex partners 46% Commercial sex workers 30% Sex with other men 1%
Giorgio et al. [49]	HIV Prevalence and Risk Factors Among Male Foreign Migrants in Cape Town, South Africa	Cape Town, South Africa	Document the HIV prevalence and key characteristics among foreign migrants in Cape Town, South Africa	Male foreign migrants in Cape Town, South Africa	Quantitative cross-sectional design	578 ϕ = 578	18–54 years	Married [in both cases, living with(out) partners/wives] Unmarried	Male foreign migrant Male foreign migrant Male foreign migrant Male foreign migrant Male foreign migrant Male foreign migrant	Three or more sex partners in last 3 months 17.9% (95% CI 13.4–22.1) Sex with other men in last 6 months 6.2, (95% CI 3.0–10.1) Sex with other men in last 6 months 27% (95% CI 21.8–32.3) Transactional sex 52.8% (95% CI 41.9–60.7) Inconsistent condom use 26.4% (95% CI 20.1–33.9) No condom use in last sexual encounter

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants	
Gilgen et al. [14]	The natural history of HIV/AIDS in a major goldmining centre in South Africa: results of a biomedical and social survey	Carletonville, Khutsong in the North-west Province	Detail the social and biomedical factors affecting the transmission of HIV in a major goldmining centre with a high prevalence of HIV infection.	Migrant miners, residents in the community close to the mines and sex worker sample	Quantitative cross-sectional design	2231 (Female ♀ = 833 Male ♂ = 1398)	13-59 years	-	Migrant women Migrant women Migrant mine-worker	Received cash for casual sex Casual partner in last 12 months Casual partner in previous year	53% Vs 30% 37% Vs 17% 53% Vs 32%
Hargreaves et al. [47]	Explaining continued high HIV prevalence in South Africa: socioeconomic factors, HIV incidence and sexual behavior change among a rural cohort, 2001–2004	Agincourt sub-district of the Bushbuckridge district in Mpumalanga province	Estimate HIV incidence and exploring evidence for changing sexual behaviors over time among men and women belonging to different socioeconomic groups in rural South Africa.	Men and women from a rural in Limpopo province	Quantitative time point cohort study 2001 and 2004	1967 Female ♀ = 1200 Male ♂ = 767	14-34 years	-	Male migrant Female migrant Male migrant Female migrant	Multiple sex partners Multiple sex partners Condom use Condom use	AOR 1.51 (1.03-2.20) AOR 1.05 (0.53-2.07) AOR 1.46 (0.98-2.19) AOR 1.48 (0.98-2.23)

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Kahn et al. [46]	Health consequences of migration: Evidence from South Africa's rural northeast (Agincourt)	Agincourt sub-district of the Bushbuckridge district in Mpu-malanga province	Review some issues contributing to the complex relationship between migration and health, and examining the negative and positive health outcomes of migration	Male labour migrants in rural KZN	Mixed study design	857 Male ♂ = 857	20–49 years	Married and single	Going home frequently Longer absence from home Working close home	Multiple sex partners Multiple sex partners (p=0.029) Multiple sex partners (p=0.071)
Lurie et al. [38]	The impact of migration on HIV-1 transmission in South Africa: a study of migrant and non-migrant men and their partners	Carletonville (Gauteng) and Richards Bay KwaZulu-Natal province	Investigate the rates of HIV-1 infection among migrant and non-migrant couples to understand the risk factors and transmission dynamics of the epidemic in South Africa	Migrant and non-migrant couples in rural KZN	Quantitative Sequential design	488 Female ♀ = 228 Male ♂ = 260	-	Married and single	Migrant men Migrant men Migrant men Migrant men	Sexual debut At least one casual partner Condom use with regular partners Lifetime sexual partners 18 versus 19 years mean age (p=0.07) 20% versus 6% (p=0.02) 10.9% versus 23.7% (p=0.04) 13.4 versus 18.2 (p=0.0001)

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
McGrath et al. [52]	Migration, sexual behaviour, and HIV risk: a general population cohort in rural South Africa	A rural district of uMkhanyakude district in northern Kwa-Zulu-Natal	Investigating the linkages of residential and migration patterns with sexual HIV risk behaviors and HIV prevalence in a population based cohort in rural Kwa-Zulu-Natal, South Africa	Resident and non-resident members in a rural area in South Africa	Quantitative survey design	4882 (Female ♀ = 2291 Male ♂ = 2591)	17–54 years	–	Migrant women Migrant women	1.55 95% CI (1.03–2.53) (p < 0.05) AOR 1.42 95% CI (1.13–1.77) (p < 0.05)

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Meekers [36]	Going underground and going after women: trends in sexual risk behavior among gold miners in South Africa	Welkom, a mining town in Free State province of South Africa	Examine trends in risk behavior among South African gold miners after a campaign to reduce HIV infection and risky sexual behavior after a prevention campaign	Gold miners in the town of Welkom	Quantitative cross sectional design—2 times points (1995 and 1997)	1128 (Male ♂ = 928, Female ♀ = 200)	38 years mean age	Married, long-term partner, other	Migrant miners. Migrant miners Migrant miners in past year Migrant miners Last sex with spouse Condom use with spouse at last sex Condom use with other partners	33% (1995) versus 35% (1997) (p < 0.01) 25% (1995) versus 13% (1997) (p < 0.01) 56% (1995) versus 70% (1997) (p < 0.01) 18% (1995) versus 26% (1997) 60% (1995) versus 67% (1997)
Ramjee and Gouws [13]	Prevalence of HIV among truck drivers visiting sex workers in KwaZulu-Natal, South Africa	Truck stops within 300 km radius of the Durban harbor	To determine HIV prevalence and risk behavior in a sample of truck drivers visiting commercial sex workers at truck stops	Truck drivers	Cross-sectional quantitative design	504 (Female ♀ = 204, Male ♂ 310)	15–48 years, 18–71 years	–	Truck drivers Truck drivers	Frequent sex with other men 42% Stopping for sex with sex workers and not using a condom 37%

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Richter et al. [29]	Migration Status, Work Conditions and Health Utilization of Female Sex Workers in Three South African Cities	Johannesburg, Rustenburg and Cape Town	Assess selected structural determinants of vulnerability of migrant FSW's (economic environment and working conditions) and whether access to health services varies between non-migrants, internal migrants and cross-border migrants.	Internal and cross-border migrants in Johannesburg, Rustenburg and Cape Town	Cross sectional quantitative design	1636 (female ♀ = 1636)	≥ 18 years	Single, regular partner, lives with regular partner	Internal migrants Cross-border migrants Cross-border migrants Cross-border migrants Sex worker Sex worker Internal migrants	94.5% versus 89.1% (p=0.02) 90.6% versus 94.6% (p=0.08) 50.0% versus 72.8% (p=0.002) AOR 2.3 (95% CI 1.5–3.7) AOR 1.5 (95% CI 0.93–2.31)

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Richter et al. [43]	Female sex work and international sport events—no major changes in demand or supply of paid sex during the 2010 Soccer World Cup: a cross-sectional study	Johannesburg, Rustenburg and Cape Town	Assess whether there was a change in demand or supply of sex work before, during and after the South African World Cup	Self-identified sex workers in Johannesburg, Rustenburg and Cape Town	Cross-sectional quantitative design-3 time points	Pre-World Cup (Female n = 601) (During = 508) (After = 538)	30 years mean age	Single, regular partner, lives alone, lives with regular partner	Recent migrants	Sex worker 2.4% (pre World Cup) versus 0.4% post World Cup (p=0.011)
Slabbert et al. [50]	Sexual and reproductive health outcomes among female sex workers in Johannesburg and Pretoria, South Africa: Recommendations for public health programmes	Johannesburg and Pretoria	Describe the socio-demographic and behavioural characteristics of sex workers in two cities, and to identify risk factors for adverse sexual reproductive health outcomes.	Foreign migrant and South African sex workers receiving clinic-, community-, or hotel-based health services in Johannesburg and Pretoria	Cross-sectional quantitative design	1830 (female n = 1422; 408) Johannesburg and Pretoria respectively	Mean = 28.6 and 33.2 years	-	Female foreign migrant sex worker	Condom use 21.5% versus 11.3%

Table 4 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size (by gender)	Age range	Marital status	Migrants	Vs non-migrants
Townsend et al. [31]	HIV prevalence and risk behaviours among foreign migrant women residing in Cape Town, South Africa	Cape Town Metropolitan area	Explore HIV prevalence and risk behaviours among foreign migrants in South Africa	Self-settled foreign migrant women in Cape Town	Cross-sectional quantitative design	935 (female ♀ = 935)	16–39 years	Married and unmarried	Cross border female migrants Cross border female migrants	5.5% range 2–11 sexual partners in past 6 months >= 15 years 5.92 (95% CI 1.30–26.97) (p=0.021)
Zuma et al. [39]	Risk factors for HIV infection among women in Carletonville, South Africa: migration, demography and sexually transmitted diseases	Carletonville District, Gauteng	Investigate the prevalence of, and risk factors for, HIV infection among women in an urban South African setting	Migrant and non-migrant women in a township in Gauteng	Mixed methods design	834 (female ♀ = 834)	13–60 years	Married, single and widowed	Migrant women Migrant women Non-migrant women Condom use	OR 4.18 (95% CI 2.25–7.76) (p=0.001) OR 2.38 (1.60–3.54) OR 1.88 (95% CI 1.02–3.45)

A dash (–) shows that response data on the variable described in subject are either missing or not reported. In Table 2 above, marital status information and odds ratios and Adjusted odds ratios for HIV outcomes of migrants were mostly not readily available. On two occasions, p-values for multivariate statistics were not presented in Table 2 (i.e. they were unavailable in primary studies data were extracted)

Each sexual behaviour outcome for migrants was measured against the comparison group (i.e. non-migrants) of the same sex except in studies focusing on specific types of migrants such; as truck drivers, mineworkers and migrant women engaging in commercial sex work

Migrant men returning home frequently had their odds for having multiple sexual partners reduced by 53% compared to those who did not (OR 0.47, $p=0.024$). Migrants working close to home were less likely to have multiple partnerships compared to those working far away (OR 0.66, $p=0.071$) [46]. One study showed that female migrants had additional partners ranging between two and 11 in the past 6 months [31]. In a mining township in Carletonville, migrant women were four times more likely to have two or more partners compared to non-migrant women (OR 4.18, 95% CI 2.25–7.76, $p<0.001$). Additional partners, other than the regular ones, were more likely to be reported by migrant women compared to non-migrants (OR 2.38, 95% CI 1.60–3.54) [39]. A study enrolling migrant men from KZN found that those who migrate had a mean lifetime number of sexual partners of 18.2 compared to 13.4, $p=0.0001$ among those who do not migrate [38]. Employed migrant men compared to those unemployed were more likely to have multiple sexual partners (50% Vs 38%). Gender specific comparisons by migration status and prevalence of multiple sexual partnerships showed increased odds for men (AOR 1.51, 95% CI 1.03–2.20) compared to women (AOR 1.05, 95% CI 0.53–2.07) [47].

Visiting Sex Workers/Engaging in Sex Work

Most studies in Table 4 reported that male migrants compared to non-migrants had a heightened likelihood of being clients of sex workers. In addition, female migration was frequently identified as a predictor and/or outcome of sex-work, this being an important risk factor for mobile women [33, 50]. In two studies conducted over a decade apart, i.e. 2002 and 2014, a high proportion of long-distance truck drivers reported frequently using the services of sex workers (37% and 30%) [41, 42]. One qualitative study reported that mineworkers often visited commercial sex workers in single-sex hostels in Mpumalanga and Northwest Provinces mining towns to cope with long detachment from spouses or main partners. Recent migrants were significantly more likely to be sex workers in South Africa shortly before the 2010 Soccer World Cup compared to recent migrants after the event (2.4% vs. 0.4%, $p=0.011$) [43]. Foreign female migrants were 2.3 times more likely to be sex workers in South Africa compared to non-mobile local women (95% CI 1.5–3.7). Internal migrants were however 1.5 times more likely to be sex workers compared to non-migrating women [42]. Other qualitative studies on women in migration situations highlighted that unemployed migrant young women were at risk of engaging in transactional and commercial sex-work as a survival strategy [48]. Compared to non-migrants, the majority of migrants were more likely to have had received cash for casual sex in the past year (53% vs. 30%) [14].

Casual Sex

Several studies in Table 4 reported increased casual sex in both migrant men and women in comparison to those who do not migrate. Casual contact was defined as any sex with a partner not considered to be a steady partner, such as a casual associate, friend etc. Migrant mineworkers in the Carletonville and Khutsong male hostels were more likely to report having casual encounters in the past compared to non-migrant men (53% vs. 32%). In the same study, migrant women compared to non-migrant women were more likely to reporting having casual sex in the past 12 months (37% vs. 17%) [14]. In another study, significant differences in the proportions and odds for casual sex by gender and migration status were observed, with migrant men compared to non-migrant men being more likely to report having at least one casual partner in the past year (20% vs. 6%, $p=0.02$). Similarly, migrant women compared to non-migrant women were 1.6 times more likely to have had casual sex in the past year (95% CI 1.03–2.53) $p<0.05$ [35].

Men Who Have Sex with Men

Three studies in Table 4 included men who have sex with men (MSM). While data in these studies do not have comparative endpoints and measures quantifying the extent of the risk of being a labor migrant, they descriptively highlight the prevalence of unprotected sex with other men in masculine same-sex workplaces and hostels (e.g. mines and factories), whether consensual or ‘forced’. A high number of long distance truck drivers in KZN (42%, $n=92$ of $N=220$) were reported to have sex with other men [41]. Based on recollections of former migrant miners, one qualitative study found that men working in mine in Impalahoek, Mpumalanga Province, regularly had unprotected sex with younger colleagues in exchange for money, protection and preferential treatment at work [37].

HIV Infection Rates

This section presents the odds ratio and hazard rate effect sizes of HIV prevalence and risk acquisition by migration status. We further present the meta-analysis results based on reported adjusted hazard ratios in Figs. 2 and 3.

HIV Prevalence

The data in Table 5 are prevalent HIV estimates for both migrants and non-migrants. In a study in rural KZN, female migrants had more than double the odds of infection (AOR = 2.55; 95% CI 2.07–3.13) compared to male non-migrants. Moreover, female migrants also had a 48% higher odds of being HIV-positive than female non-migrants (AOR

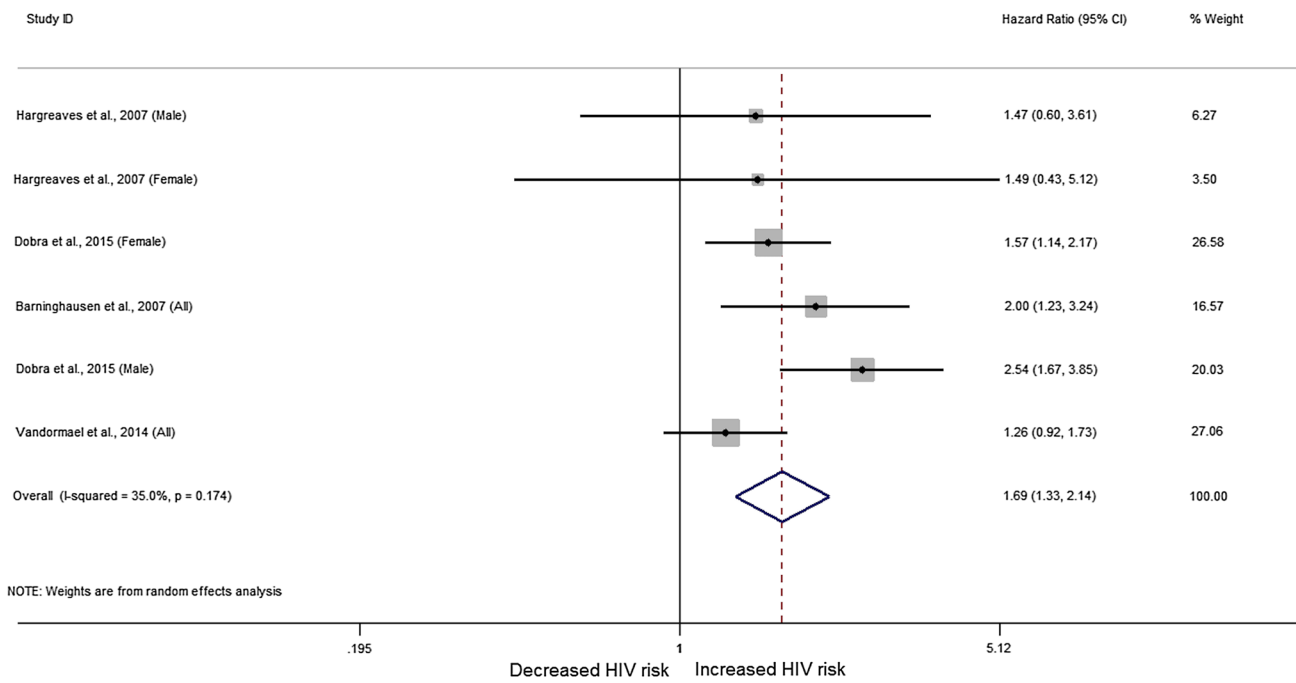
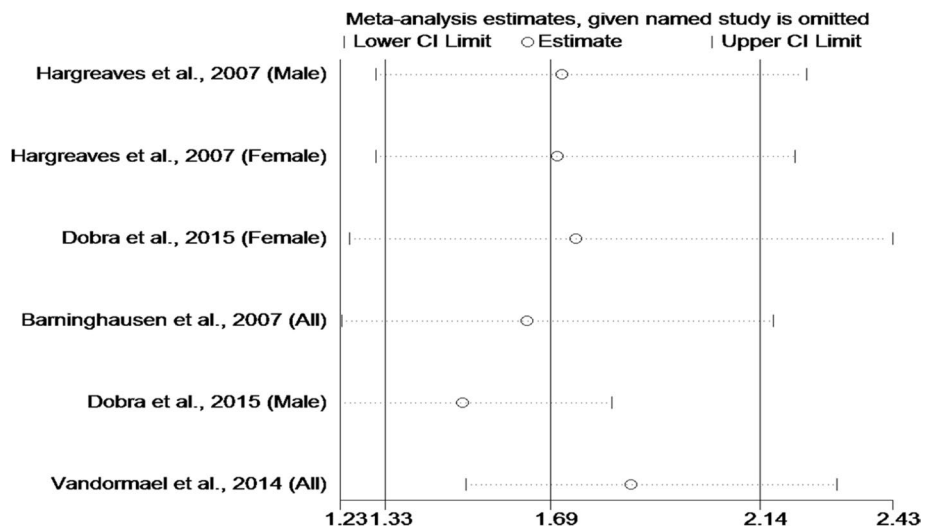


Fig. 2 Effects of migration on HIV acquisition. *Note* The mid-point of the dark box represents the point effect estimate for each study. The area of the box represents the weight given to the study. Horizontal

line shows 95% CIs of the effect estimate for each study. Diamond represents the combined-effect estimate and its width shows 95% confidence interval

Fig. 3 HIV incidence of migrants compared to non-migrants and confidence intervals. *Note* Combined effect size parameters at 95% CIs are represented by the vertical lines



1.48, 95% CI 1.23–1.77) [51]. An earlier study found that migrant women were more likely to be HIV positive than their non-migrant counterparts (51% vs. 39%; $p=0.002$) [14]. Another study showed that migrant women were 1.5 times more likely to be infected by HIV than non-migrant women (OR 1.52, 95% CI 1.01–2.28, $p=0.046$) [39], while 25.9% of migrant men compared 12.7% of non-migrant men were infected with HIV (OR 2.4, 95% CI 1.1–5.3; $p=0.029$) [38]. Migrant men compared to partners of migrant men

were more likely to be infected by STI's, including HIV (OR 1.54, 95% CI 1.00–2.37; $p=0.049$) [39]. HIV infection among non-residents compared to residents was AOR 1.8 (95% CI 1.3–2.4) for men and AOR 1.5 (95% CI 1.2–2.0) for women in a rural area in KZN [52]. More recently, in the same DSS, non-residents compared to residents in the study area had higher odds of infection: AOR 1.19 (95% CI 1.07–1.33) for men and AOR 1.8 (1.10–1.26) for women [53]. Other results by duration of mobility associated with

Table 5 Quantitative studies with HIV prevalence measures

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants versus non-migrants
Baltazar et al. [33]	HIV Prevalence and risk behaviors among Mozambicans working in South African Mines	Border town between South Africa and Mozambique, Ressano Garcia	Estimate the prevalence of HIV and associated risk behaviors, and assessing the use of and access to HIV prevention programs within this population	Mozambican men working in South African mines	Quantitative Cross-sectional design	430 (male) $\sigma = 430$	23–68 years	Never married Married/cohabitating Widower/divorced/separated	The prevalence of HIV among Mozambican mineworkers working in South Africa (22.3%, 95% CI 17.8–26.9) was high and contrasts sharply with that in the general male South Africa population age 15–49 years of age (14.5%, 95% CI range 12.8%–13.3%)
Camlin et al. [17]	Gender, migration and HIV in rural KwaZulu-Natal, South Africa	A rural district of uMkhanyakude district in northern KwaZulu-Natal	Examining whether the associations between migration differ for men and women so as to identify pathways through which women's migration contributes to their high infection risk	Men and women from rural KZN	Quantitative Cross-sectional design	4731 Female $\sigma = 3297$ Male $\sigma = 1432$	15–54 years	Married and unmarried	Female migrants had more than double the odds of infection (aOR = 2.55; 95% CI 2.07–3.13) compared to male non-migrants Female migrants also had 48% higher odds of being HIV-positive than female non-migrants (aOR 1.48, 95% CI 1.23–1.77)

Table 5 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants versus non-migrants
Delany-Moretlwe et al. [42]	HIV prevalence and risk in long-distance truck drivers in South Africa: a national cross-sectional survey	Long distance truck-stops in South Africa	Determine the prevalence of HIV, STIs, and associated risk behavior in long-distance truck drivers in South Africa.	Long-distance truckers, co-drivers or assistants	Quantitative cross-sectional design	1900 (Male ♂ = 1900)	18–71 years	Married living with spouse or sexual partner Married lives alone Unmarried living with sexual partner Not married not living with sexual partner	Spending more than 4 weeks on the road increased odds of HIV infection by 1.5 times compared to spending less than a week on the road (95% CI 0.9–2.3) Truck drivers were 4 times more likely to be HIV positive compared to the men of the same age in the general population 4.26 (95% CI 2.4–28).
Giorgio et al. [49]	HIV prevalence and risk factors among male foreign migrants in Cape Town, South Africa	Cape Town, South Africa	Document the HIV prevalence and key characteristics among male foreign migrants in Cape Town, South Africa	Male foreign migrants in Cape Town, South Africa	Quantitative cross-sectional design	578 ♂ = 578	18–54 years	Male foreign migrant Male foreign migrant Male foreign migrant Male foreign migrant Male foreign migrant	HIV prevalence for foreign migrant was estimated to be 8.7% (95% CI 5.4–11.8) compared men in the general population 14.5%
Gilden et al. [14]	The natural history of HIV/AIDS in a major gold-mining centre in South Africa: results of a biomedical and social survey	Carletonville, Khutsong in the Northwest Province	Detail the social and biomedical factors affecting the transmission of HIV in a major gold-mining centre with a high prevalence of HIV infection.	Migrant mineworkers, resident adults in the community close to the mines and sex worker sample	Quantitative cross-sectional design	2231 (female ♀ = 833 Male ♂ = 1398)	13–59 years	–	Migrant women were more likely to be HIV positive than non-migrant women (51% versus 39%; P < 0.002).

Table 5 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demo-graphic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants versus non-migrants
Lurie et al. [38]	The impact of migration on HIV-1 transmission in South Africa: a study of migrant and non-migrant men and their partners	A rural district of uMkhanyakude district in northern KwaZulu-Natal province	Investigate the rates of HIV-1 infection among migrant and non-migrant couples to understand the risk factors and transmission dynamics of the epidemic in South Africa.	Migrant and non-migrant couples in rural KZN	Quantitative Sequential design	488 female ♀ = 228 ♂ = 260	–	Married and single	25.9% of migrant men compared 12.7% of non-migrant men were infected with HIV OR 2.4 (95% CI = 1.1–5.3) (p = 0.029).
McGrath et al. [52]	Migration, sexual behaviour, and HIV risk: a general population cohort in rural South Africa	A rural district of uMkhanyakude district in northern KwaZulu-Natal	Investigating the linkages of residential and migration patterns with sexual HIV risk behaviors and HIV prevalence in a population based cohort in rural KwaZulu-Natal, South Africa	Resident and non-resident members in a rural area in South Africa	Quantitative survey design	4882 (female ♀ = 2291 male ♂ = 2591)	17–54 years	–	Migrants to compared to residents in the study area in men (AOR 1.19, 95% CI 1.07–1.33) and in women (1.18, 1.10–1.26).
Ramjee and Gouws [13]	Prevalence of HIV Among Truck Drivers Visiting Sex Workers in KwaZulu-Natal, South Africa	Truck stops within 300 km radius of the Durban harbor	To determine HIV prevalence and risk behavior in a sample of truck drivers visiting commercial sex workers at truck stops	Truck drivers	Cross-sectional quantitative design	504 (female ♀ = 204, Male ♂ 310)	15–48 years 18–71 years	–	HIV prevalence among truck drivers was 56% (95% CI 51–62%) compared to that sex workers 56% (95% CI 49–63%). (p = 0.956)

Table 5 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demo-graphic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants versus non-migrants
Slabbert et al. [50]	Sexual and reproductive health outcomes among female sex workers in Johannesburg and Pretoria, South Africa: Recommendations for public health programmes	Johannesburg and Pretoria	Describe the socio-demo-graphic and behavioural characteristics of sex workers in two cities, and to identify risk factors for adverse sexual reproductive health outcomes	Foreign migrant and South African sex workers receiving clinic-, community-, or hotel-based health services in Johannesburg and Pretoria	Cross-sectional quantitative design	1830 (female ♀ = 1422; 408) Johannesburg and Pretoria respectively	Mean = 28.6 and 33.2 years	–	Foreign sex workers had a higher odds of infection compared to South African sex workers 1.1 (0.8–1.5)
Townsend et al. [50]	HIV prevalence and risk behaviours among foreign migrant women residing in Cape Town, South Africa	Cape Town Metropolitan area	Exploring HIV prevalence and risk behaviors among foreign migrants in South Africa	Self-settled foreign migrant women in Cape Town	Cross-sectional quantitative design	935 (female ♀ = 935)	16–39 years	Married and unmarried	HIV prevalence among female migrants was AOR 1.07 (95% CI 1.05–1.10)
Welz et al. [51]	HIV prevalence and socio-demographic covariates such as mobility	A rural sub-district of uMkhanyakude in northern KZN	Estimate the prevalence of HIV and its association with socio-demo-graphic factors, including mobility and migration in a rural area in South Africa	Resident and non-resident household members in Africa Centre Demographic surveillance area	Cross-sectional quantitative design	2009 (female ♀ = 970, male ♂ = 982)	15–54 years	Married, never married and separated	The HIV infection among non-residents compared with residents was AOR 1.8 (95% CI 1.3–2.4) for men and AOR 1.5 95% CI 1.2–2.0) for women.
Zuma et al. [39]	Risk factors for HIV infection among women in Carletonville, South Africa: migration, demography and sexually transmitted diseases	Carletonville District, Gauteng	Investigating the prevalence of, and risk factors for, HIV infection among women in an urban South African setting	Migrant and non-migrant women in a township in Gauteng	Mixed methods design	834 (female ♀ = 834)	13–60 years	Married, single and widowed	Migrant women are at higher risk of HIV infection than non-migrant women OR 1.52 (95% CI (1.01–2.28) (p = 0.046)

Table 5 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demo-graphic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants versus non-migrants
Zuma et al. [40]	Risk factors of sexually transmitted infections among migrant and non-migrant sexual partnerships from rural South Africa	A rural district of uMkhanyakude district in northern KwaZulu-Natal	Examining the effects of urban–rural circular labour migration on the spread of HIV and other STIs in rural South Africa. Accordingly, the premise here is that HIV and other STI shares similar behavioral risk factors	Migrant men and women in rural KZN	Quantitative study design	553 (female ♀ = 253 male♂ = 300)	18–69 years	–	Migrant men compared to partners of migrant men were more likely to be infected by STI's including HIV OR 1.54 (95% CI 1.00–2.37) (p=0.049).

A dash/hyphen (–) in a cell shows that response data on the variable in the subject are either missing or not reported in the primary study In Table 3 above, marital status information, age categories of migrants and univariate and multi-variate results on the effect of migration on prevalent HIV infections were in a few occasions unavailable

higher HIV prevalence i.e. spending more time travelling per-month, increased the odds of HIV infection by 1.5 times compared to spending less time travelling per-month (95% CI 0.9–2.3) [42]. Truck drivers were four times more likely to be HIV positive compared to the men of the same age in the general population AOR (4.26 (95% CI 24–28) [42].

Hazard of Acquiring HIV

Four of the studies with multivariate statistics for incident infections are presented in Table 6. For instance, male migrants compared to non-migrants were more likely to acquire HIV (AHR 2.54, 95% CI 1.67–3.85; p=0.0001) and female migrants compared to non-migrants were more likely to acquire HIV (AHR 1.57, 95% CI 1.14–2.17; p=0.006) [3]. In KZN Province, non-migration reduced the risk of HIV acquisition by over 50% (AOR 0.4988, 95% CI 1.23–3.24; p=0.005) [44].

Meta-analysis Results

To examine the overall estimate of the effect of migration on increasing the risk of acquiring HIV, we statistically summarized the six estimates from four studies, as shown in Table 6. According to our meta-analysis (Fig. 3), exposure to migration was associated with a 69% increase in the HIV acquisition risk (95% CI 1.33–2.14). We found low to moderate heterogeneity in the combined effect size, (I² = 35.0%, p=0.17). Our sensitivity analysis, which was conducted by omitting each study in turn, did not alter the significant relationship between migration and risk of HIV acquisition. Our study also suggests that the removal of small studies, such as Hargreaves et al. [47], did not alter the significance of our overall findings.

Discussion

The risk of acquiring HIV increased by 69% (95% CI 1.33–2.14) in migrants compared to non-migrants, according to our meta-analysis results of four studies. These studies were conducted over eight years (2007–2015), a period covering two HIV treatment eras; one in which it barely existed, with an associated increase in prevalence and incidence, and the latter in which it was widely available and HIV incidence decreased in the general population. Despite universal ART coverage being achieved after 2010, the meta-analysis result suggests that HIV incidence due to migration remained high, as demonstrated in a cohort study in Uganda [20]. HIV prevalence was high in migrants compared to non-migrants, the largest difference being across genders, with female migrants having more than double the odds of infection (aOR = 2.55; 95% CI 2.07–3.13) compared to male non-migrants [17].

Table 6 Quantitative studies with hazard of acquiring HIV measures

Reference	Title	Study location	Focus/aim of study	Socio-demo-graphic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants vs Non-migrants
Barnighausen et al. [44]	The socio-economic determinants of HIV incidence: evidence from a longitudinal, population-based study in rural South Africa	A rural district of uMkhanyakude in northern KwaZulu-Natal	Investigating the effect of measures of socio-economic status (i.e. educational attainment, household wealth, per-capita household expenditure) and migrancy on HIV incidence.	Rural men and women testing negative for HIV during the first and second round of the surveillance 2003–2004 and 2004–2005	Quantitative longitudinal design	3325 female ♀ = 2008 Male ♂ = 1317	15–49 years	Married 374 Not married with partner 1264 Not married without partner 1687	Compared to non-migrants non-migrants had a reduced hazard of acquiring HIV AOR 0.4988 (95% CI 1.23–3.24) (p=0.005).
Dobra et al. [3]	Space-time migration patterns and risk of HIV acquisition in a rural South African population: a population-based cohort study	A rural district of uMkhanyakude district in northern KwaZulu-Natal	Analyzing high resolution space-time mobility data to ascertain casual relationships between mobility patterns and HIV risk acquisition.	Men and women who had at least 2 recorded HIV negative tests before January 1 2004 and resident in the uMkhanyakude surveillance site (Africa Centre Demographic Information System)	Quantitative longitudinal design	17 743 (Female ♀ = 10,749 Male ♂ = 6995)	≥ 15 years	Married and unmarried	Compared to non-migrants male migrants the hazard of HIV infection was AOR 2.54 (95% CI 1.67-3.85) (p<0.0001) Female migrants compared to female non-migrants was AOR 1.57 (95% CI 1.14–2.17) (0.006)

Table 6 (continued)

Reference	Title	Study location	Focus/aim of study	Socio-demographic profile	Methodology	Sample size by gender	Age range	Marital status	Migrants vs Non-migrants
Hargreaves et al. [47]	Explaining continued high HIV prevalence in South Africa: socioeconomic factors, HIV incidence and sexual behaviour change among a rural cohort, 2001–2004	Agincourt sub-district of the Bushbuckridge district in Mpumalanga province	Estimating HIV incidence and exploring evidence for changing sexual behaviors over time among men and women belonging to different socioeconomic groups in rural South Africa	Men and women from a rural in Limpopo province	Quantitative longitudinal design (time-point based)	1967 Female ♀ = 1200 Male ♂ = 767	14–34 years	–	Compared to female non-migrants at both time points increased risk of seroconversion AOR 1.47 (95% CI 0.60–3.61) Compared to male non-migrants male migrants at both time points increased risk of seroconversion AOR 1.49 (1.49 95% CI 0.60–3.61)
Vandormael et al. [34]	Use of antiretroviral therapy in households and risk of HIV acquisition in rural KwaZulu-Natal, South Africa, 2004–2012: a prospective cohort study	A rural district of uMkhanyakude district in northern KwaZulu-Natal	Assessing an individual hazard of HIV associated with ART coverage among household members of the opposite sex	Men and women co-residing with opposite sex household member(s) taking ART	Quantitative cohort study design	14,505 (female ♀ = 8546 male ♂ = 5959)	15–50 years	Both married and unmarried	Non-residency was associated with an increased HIV seroconversion hazard 1.26 (0.92–1.73) p = 0.1442

A dash/hyphen (–) in a cell shows that response data on the variable described in subject are either missing or not reported. In Table 3 above, marital status information and data for age categories of migrant samples were in a few occasions unavailable

Another key finding was that sexual practices (i.e. multiple partnering, limited condom use, client to sex workers/engaging in sex work, casual sex and transactional sex) are important mechanisms shaping the risk of HIV infection among those who migrate, confirming an earlier observation [21]. We highlight the intersectionality of bio-demographic and structural factors in modifying the continuum of HIV risk in migrants at an ecological level in South Africa [48]. For instance, we found that unemployed, migrant young women had a higher risk of having additional sex partners and being involved in sex work or transactional sex compared to non-migrants.

Multiple partnering was frequently identified as high among migrants compared to non-migrants, with having additional sexual partners when separated from the main partner during a migration episode being significantly increased across gender and age group. In two studies, female migrants (34.4 years, mean) were 4.2 times more likely to have two or more lifetime sexual partners compared to non-migrants [39]. Male migrants (37.4 years, mean) had an average of 18.2 compared to 13.4 lifetime sexual partners in non-migrants compared to non-migrants [38], highlighting large differences by migration status. This age and gender clustering challenges the traditional male-infecter model, which presumes that only prime-aged migrant men are vulnerable to HIV risk through their interaction with external partners and thereby infect their wives or regular partners. As suggested in Ferrand [53], easy generalizations, such as viewing separate and static characteristics of individuals as independent risk factors of HIV, are no longer plausible, instead, the interaction of social and biological influences (age, gender, nature of sexual relationships) jointly increases the risk of infection. This study showed that both migrant men and women reported having a greater number of additional sexual partners outside their community of origin, but gender differences in the experience of risk emerged. Typically, men with multiple partners had better paying jobs, and were therefore more likely to afford additional partners and further expand their sexual networks while maintaining multi-local partnerships in comparison to those who do not migrate. In contrast, women, in poorly paying jobs, as is often the case with female migrant labour [17], send most of their earnings home i.e. two-thirds higher than men's [54], and thus may rely on multiple sexual partners or engage in transactional sex as an additional source of income, as noted in some qualitative studies [18, 19]. Here we demonstrated that the finding for women did not necessarily conflict with that for men. This supports our initial hypothesis that employment is not protective for women, as livelihoods associated with migration often include commercial sex work and transactional sex.

It follows that further studies exploring the migrant employment continuum (i.e. looking for employment to

already working) are needed to confirm the findings about the intersections of various correlates of migration and sexual behaviour outcomes. A synthesis of the sexual behaviour data reveals that women who migrate were associated with increased prevalence of HIV risk behaviours. Young (or older), employed (or unemployed) and migrating men and women reported having more multiple sex partners and transactional sex than non-migrants. Moreover, that some women who engaged in risky sexual contact were employed [48] reflects that economic insecurity (as conventionally interpreted), may not completely explain why they are disproportionately at greater risk of HIV infection. The literature likely explaining this highlights that material deprivation and consumerism instigates this sex-gift exchange, and influences young women's high sexual risk taking [55, 56].

In three of the studies, adult men who did not migrate with their spouses/partners, returned home less frequently or migrated to the furthest destinations were associated with high additional sexual partnering [10, 42, 46]. In light of this result, it is possible to infer that increased risky sexual behaviour in married men is driven by extraordinarily long episodes of absence from home, i.e. mineworkers and long-distance truck drivers were frequently reported to have casual sexual partners.

There are two important observations emerging from this finding. Firstly, it indirectly affirms the evidence from other studies in rural South Africa showing that migrant men who work close to their home communities were less likely to report multiple sexual partners than those travelling to destinations further afield (returning once or twice a year), suggesting that short distance migration is a protective factor to sexual risk [17]. Secondly it gives credence to our examination of migration definitions in this study and forthcoming studies that may use mobile application technology to collect real-time data (i.e. on distance travelled and pattern of migration) to test more thoroughly the proposition that detailed measurement of migration (i.e. length of time away and destination correlates) is a key HIV independent risk factor.

However, these results may have limited explanatory value, due to a number of methodological challenges. For instance, many of the existing studies examining multiple partnering obtained no data on the characteristics of the sexual partnerships, such as the length of overlaps between and the type of sexual partners, information that is particularly important in determining transmission during concurrent partnerships. If characteristics of the partner or partnership are not collected, it is difficult to determine their epidemiological interpretation, given that some partnerships may be once-off sexual encounters. For instance, in one study reporting multiple sexual partnering in women, up to 11 sexual partners were reported, although it may not be known with certainty whether additional partners were encountered

during on-going specific partnerships. It is therefore important that definitions of multiple partnering are standardized, particularly in quantitative studies, to avoid misreporting, given its implications for HIV risk. Similarly, it is difficult to accurately interpret results from studies measuring migration differently. Systematic attention to definitions would simplify cross-study comparison of multiple partnering results, and may render effective the need for clear messages aimed at reducing multiple partnerships, irrespective of whether those overlap in time [57].

A few studies (four) measured HIV incidence and 13 reported on prevalence. Unfortunately, with the shortage of data on new HIV diagnoses as opposed to prevalence, it is impossible to ascertain any causal relationship, as migrants may have been infected in the past when they had different sexual behaviours. This finding implies the need for more cohort studies on migrant HIV risk to rigorously estimate the effect of mobility on new infections. Accordingly, this undertaking is consistent with the UNAIDS current funding model and package of prevention strategies, which involves identifying main modes of HIV transmission, key affected populations, and core epidemiological trends to ensure a greater impact on reducing new infections [1].

Conclusion

Mobility is highly associated with increased prevalence of HIV risk behaviours, and confers up to 69% increase in the risk of HIV acquisition. Studies included in this review documented increased multiple sexual partnering, unprotected sexual intercourse, visiting sex workers and engaging in sex work in migrants compared to non-migrants. Escalation of this sexual behaviour and risk of HIV acquisition among migrants in comparison to non-migrants calls for increased reliance on the targeted and best-combination HIV prevention strategies. Our review found only four studies on migration and HIV risk acquisition, emphasizing the need for incidence data to establish if the timing of new infections corresponds with the migrant sexual behaviours above, and can predict future risk patterns. The implications of this study include monitoring and tracking key trends of the epidemic in migrants to evaluate country level success towards the UNAIDS's focus on optimizing the reduction of new HIV infections. Effective combination HIV prevention strategies that target migrant populations are urgently required.

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Compliance with Ethical Standards

Conflict of interest The authors declare no conflict of interest.

Ethical Approval The Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BREC) Durban, South Africa, gave full ethics approval for this study.

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