# Supplementary Materials

## A. PRISMA-ScR checklist

Table 1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

| **Section** | **Item** | **PRISMA-ScR checklist item** | **Reported on page #** |
| --- | --- | --- | --- |
| Title | 1 | Identify the report as a scoping review. | 1 |
| Abstract | 2 | Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives. | 1 |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach. | 2 |
| Objectives | 4 | Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives. | 2 |
| Protocol and registration | 5 | Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number. | 2 |
| Eligibility criteria | 6 | Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale. | 3 |
| Information sources | 7 | Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed. | 3 |
| Search | 8 | Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated. | 3 |
| Selection of sources of evidence | 9 | State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review. | 3 |
| Data charting process | 10 | Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators. | 3 |
| Data items | 11 | List and define all variables for which data were sought and any assumptions and simplifications made. | 3 |
| Critical appraisal of individual sources of evidence | 12 | If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate). | NA |
| Synthesis of results | 13 | Describe the methods of handling and summarizing the data that were charted. | 3-4 |
| Selection of sources of evidence | 14 | Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram. | 4-5 |
| Characteristics of sources of evidence | 15 | For each source of evidence, present characteristics for which data were charted and provide the citations. | 5-16 |
| Critical appraisal within sources of evidence | 16 | If done, present data on critical appraisal of included sources of evidence (see item 12). | NA |
| Results of individual sources of evidence | 17 | For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives. | Supplementary Materials, part B |
| Synthesis of results | 18 | Summarize and/or present the charting results as they relate to the review questions and objectives. | 16-21 |
| Summary of evidence | 19 | Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups. | 16-21 |
| Limitations | 20 | Discuss the limitations of the scoping review process. | 21 |
| Conclusions | 21 | Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps. | 21 |
| Funding | 22 | Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review. | 21 |

## B. Reference tables

Table 2: Reference table of the included quantitative studies

| **References** | **Location** | **Design** | **Subpopulation** | **Syndemic conditions studied** | **Outcomes** | **Statistics used to model interaction** | **Key findings** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Achterbergh et al. 2021** | Netherlands | Randomized controlled trials (during 12 months intervention group (N=76) received tailored feedback and help-seeking advice on mental health screening to increase help-seeking behaviors (primary endpoint) as well as reducing sexual risk behaviors and STI incidence (secondary endpoint) ; control group (N=79) consisted of participants that didn't received results of their mental health screening nor tailored feedback or help-seeking advice) |  | depression, IPV, sexual compulsivity, anxiety, AUD, discrimination, substance use disorder, ADHD, alexithymia | engaging in sexual risk behaviors, HIV diagnosis, STI diagnosis, help-seeking behaviors | regression analysis using a summation score | This syndemic-based intervention to enhance help-seeking among high-risk MSM failed to improve help-seeking behaviours, STI incidence and sexual risk. Nonetheless, the extremely high incidence of STI incidence and mental health-related problems call for other type of interventions. |
| **Batchelder et al. 2019** | USA | Cross-sectional | MSM with a history of childhood sexual abuse | depression, PTSD, anxiety, substance use disorder | engaging in sexual risk behaviors, healthcare use, STI diagnosis | regression analysis using a summation score, significant product term in regression | There is an additive relationship between the number of psychiatric diagnoses and ER visits as well as condomless anal sex. No relationship was found between psychiatric diagnoses and STD. No interaction was found. |
| **Beymer et al. 2016** | USA | Longitudinal (66 months) | Latino MSM | substance use, IPV, sexual risk behaviors, STI | HIV diagnosis | Cox proportional hazards models | In this sample of Latino MSM, predictors of HIV seroconversion included history of STI, condomless anal sex, Methamphetamine Use, Central American birthplace, experience of IPV and same ethnicity of last sexual partner. |
| **Biello et al. 2014** | Vietnam | Cross-sectional | MSM engaged in sex work | depression, substance use, CSA, AUD, violence | engaging in sexual risk behaviors | regression analysis using a summation score | Experiencing a higher number of syndemic condition was associated with greater odds of engaging in condomless anal sex in this sample of Vietnamese male sex workers who have sex with men. This relationship was mainly driven by childhood sexual abuse and alcohol use disorder |
| **Biello et al. 2016** | Latin America | Cross-sectional | MSM living with HIV | depression, IPV, suicidality, sexual compulsivity, CSA, AUD, chemsex | adherence to antiviral medication, healthcare use, linkage to HIV care | regression analysis using a summation score | Experimenting syndemic conditions was associated with less engagement in HIV-related care, uptake of ART and adherence to ART among this sample of HIV positive MSM living in Latin America |
| **Blashill et al. 2020** | USA | Cross-sectional | Latino MSM | depression, substance use, IPV, binge drinking, CSA, polysubstance use, incarceration, unstable housing, poverty | PrEP-related outcomes | regression analysis using a summation score | Structural barriers such as unstable housing represent greater obstacles to being aware of the existence of PrEP than psychosocial conditions. However, once PrEP has been initiated, psychosocial conditions like intimate partner violence account for a greater variance in PrEP adherence. |
| **Blondeel et al. 2021** | Portugal | Cross-sectional |  | sexual risk behaviors, chemsex, frequenting gay social venues | HIV diagnosis, STI diagnosis | cluster analysis | 6 clusters with diverse patterns of sexual risk taking and STI/HIV vulnerability were identified. Among these clusters, the one with the highest HIV prevalence was the oldest one, reported the most condomless anal sex and had sex the most frequently with transgender partners, women and sex workers. |
| **Brandstrom and Pachankis 2018** | Sweden | Population-based cohort study | disagregated data for Men who have Sex with Men and Women | depression, binge drinking, suicidality, violence | HIV diagnosis | regression analysis using a summation score, observed/expected ratio | Sexual minority men are more likely to be diagnosed with HIV and to suffer from psychosocial conditions. However, the clustering of syndemic conditions and HIV was only found for gay men, not bisexual men |
| **Buttram et al. 2015** | USA | Mixed Quantitative cross-sectionnal and qualitative analysis with grounded theory | Black MSM | substance use disorder, violence, general mental distress |  | no interaction studied | Compared to White MSM, Black MSM experienced a wide range of disparities such as substance use, substance use disorder, exchange sex, unstable housing, unemployment, low educational attainment, arrest history, low social support and low satisfaction with one's living situation |
| **Byg et al. 2016** | USA | Cross-sectional | MSM living with HIV | depression, IPV, substance use disorder | glycemic control | multivariate linear regression | Poorer glycemic control was associated with a detectable viral load, high triglycerides and substance use |
| **Card et al. 2018** | Canada | Cross-sectional |  | depression, polysubstance use | engaging in sexual risk behaviors | moderation analysis, mediation analysis | AUDIT scores were not associated with risky sexual behaviors. The association between polysubstance use and depression was associated with greater odds of serodiscordant condomless anal sex. 18,2% of the effect of depression on serodiscordant CAS was mediated by polysubstance use. |
| **Carrico et al. 2018** | USA | Intact group design |  | depression, CSA, substance use disorder, sleep disturbance, childhood abuse | dysregulation of the hypoathalamic-pituitary-adrenal axis | moderation analysis | In meth-using MSM living with HIV, there is a disaggregation of the functional relationship between ACTH and cortisol, compared to HIV-negative, non-meth-using men |
| **Chakrapani et al. 2017** | India | Cross-sectional |  | depression, alcohol use, violence | engaging in sexual risk behaviors | regression analysis using a summation score | In this sample of Indian MSM, there was a positive relationship between the number of syndemic conditions and sexual risk taking. This relationship was moderated by resilient coping but not by social support. |
| **Chakrapani et al. 2019b** | India | Cross-sectional |  | substance use, alcohol use, violence | engaging in sexual risk behaviors | Relative Excess Risk due to Interaction (RERI), significant product term in regression, mediation analysis, path analysis | In this population-based study of Indian MSM, the authors found empiric support to three models of interacting epidemics : synergistically interacting epidemics, serially causal epidemics and mutually causal epidemics, with the strongest support for the model of synergistically interacting epidemics |
| **Chakrapani et al. 2020** | India | Pretest-posttest nonequivalent groups (during 12 months intervention group (N=229) received a Motivational Interview-based HIV prevention intervention to reduce condomless anal intercourse by improving condom self-efficacy and by addressing co-occurring psychosocial conditions ; control group (N=230) consisted of MSM receiving standard of care in another NGO) |  | depression, AUD, internalised homophobia | engaging in sexual risk behaviors | Relative Excess Risk due to Interaction (RERI), significant product term in regression, mediation analysis | This motivational interview-based intervention guided by syndemic theory was effective in improving consistent condom use and in reducing the three psychosocial conditions investigated (depression, alcohol use and internalised homophobia). Synergy was present for depression and alcool use and for depression and internalised homophobia on inconsistent condom use. Mediation analysis revealed that the intervention led to a reduction in alcool use and internalised homophobia which improved condom self-efficacy which ultimately led to an improvement in consistent condom use |
| **Chandler et al. 2020a** | USA | Cross-sectional | Black MSM | depression, IPV, binge drinking, polysubstance use | PrEP-related outcomes | regression analysis using a summation score, Relative Excess Risk due to Interaction (RERI) | BMSM on PrEP were most likely to suffer from IPV, engage in problematic binge drinking and polysubstance use. Synergy was found between all the syndemic conditions |
| **Chandler et al. 2020b** | USA | Cross-sectional | Black MSM | depression, IPV, binge drinking, polysubstance use, sexual risk behaviors | HIV\_screening | regression analysis using a summation score, Relative Excess Risk due to Interaction (RERI) | The men most at risk were more likely to test, such as the syndemic variables did not adequately explain discrepancy in HIV screening among BMSM. Synergy in preventing HIV screening was present between poly drug use, depression and binge drinking as well as between binge drinking, depression and sexual risk behaviors. |
| **Chandler et al. 2020c** | USA | Cross-sectional | Black MSM engaged in sex work | depression, IPV, polysubstance use, violence | STI diagnosis | mediation analysis, Structural Equation Modeling | In this sample of BMSM engaged in sex work, there were a direct relationship between syndemic conditions and engagement in sex work as well as between engagement in sex work and past-year STI diagnosis. Furthermore, syndemic conditions were found to partially mediate the relationship between engagement in sex work and past-year STI, accounting for 64,2% of this relationship. |
| **Chuang et al. 2018** | Taiwan | Cross-sectional |  | IPV, discrimination, substance use disorder | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | Experiencing a greater number of syndemic conditions was associated with higher odds of self-reported postive HIV status but not with condomless anal sex nor number of partners |
| **Dyer et al. 2012** | USA | Cross-sectional | Black MSM | depression, substance use, IPV, binge drinking, sexual compulsivity, stress | engaging in sexual risk behaviors, syndemic conditions as the outcomes | regression analysis using a summation score | Gay-related and non-gay-related victimization in school, perception of failures in masculinity, social connectedness, internalized homophobia, discrimination and life satisfaction were associated with having 2 or more syndemic conditions. Furthermore, having 3 or more syndemic conditions was associated with condomless anal sex |
| **Dyer et al. 2020** | USA | Longitudinal (12 months) | Black MSM, disagregated data for Black Men who have Sex with Men and Women | depression, substance use, IPV, binge drinking, incarceration, discrimination, experience of trauma | STI diagnosis | Latent Class Analysis/Latent Profile Analysis, mediation analysis | Different syndemic profiles were found for BMSMO and BMSMW. Furthermore BMSMO had higher STI incidence compared to BMSMW and this difference in incidence was partly mediated by high risk sexual behaviors. |
| **Eaton et al. 2013** | South Africa | Cross-sectional | Men who have Sex with Men and Women | substance use, IPV, CSA, alcohol use, sexual risk behaviors, violence | having sex with both men and women | no interaction studied | In multivariate analysis, self-reported positive HIV status and childhood sexual abuse were associated with higher odds of reporting sex with both men and women. Furthermore recent interpartner violence, recent sexual violence and childhood sexual abuse were significantly inter-associated but were not associated with sexual risk or substance/alcohol use |
| **Ferlatte et al. 2014** | Canada | Cross-sectional |  | depression, substance use disorder, loneliness | engaging in sexual risk behaviors | regression analysis using a summation score | Experiencing multiple anti-gay experiences was associated with syndemic conditions : a greater number of syndemic conditions was then subsequently associated with greater odds of engaging in serodiscordant condomless anal sex |
| **Ferlatte et al. 2015** | Canada | Cross-sectional |  | depression, substance use, anxiety, tobacco use, sexual risk behaviors, STI, HIV | suicidality | regression analysis using a summation score | Syndemic theory is appropriate for studying suicide ideation and attempts among MSM. Notably, those reporting 3 syndemic conditions had 6.9 times the odds of suicide ideation and 16,29 times the odds of suicide attempts, mainly driven by anxiety and depression. |
| **Ferlatte et al. 2018a** | Canada | Cross-sectional |  | substance use, IPV, binge drinking, suicidality, general mental distress | STI diagnosis | regression analysis using a summation score, Relative Excess Risk due to Interaction (RERI) | Healthcare discrimination, a cumulative count of syndemic and a cumulative count of antigay stigma were associated with syphilis diagnosis in the past 12 months. The RERI for cumulative count of syndemic conditions was not significant. IPV and substance use were associated with syphilis, after adjusting for other syndemic conditions. |
| **Ferlatte et al. 2018b** | Canada | Cross-sectional | disagregated data for Men who have Sex with Men and Women | depression, substance use, binge drinking, suicidality, anxiety | engaging in sexual risk behaviors, syndemic conditions as the outcomes | regression analysis using a summation score | Gay men were more likely to experiment two or more syndemic conditions compared to bisexual men and female-partnered MSM. This difference was mainly driven by higher odds of consuming party drugs and being treated for anxiety/depression. Furthermore, being single, younger than 45 years old, of Indigenous ancestry, earning less than $60,000 per year and living in an urban environment were also associated with higher odds of experimenting two or more syndemic conditions |
| **Friedman et al. 2014** | USA | Cross-sectional | disagregated data for Men who have Sex with Men and Women | depression, sexual compulsivity, unstable housing, violence | engaging in exchange sex, engaging in sexual risk behaviors, engaging in chemsex | regression analysis using a summation score, hierarchical negative binomial regression | Among MSMW, syndemic conditions explained 31,1% of the variance in exchange sex but only 3.6% of the variance in chemsex. Exchange sex, in turn was associated with serodiscordant condomless anal sex while chemsex alone was not. Furthermore no direct association between syndemic conditions and serodiscodant condomless anal was found |
| **Friedman et al. 2015** | USA | Longitudinal (78 months) | MSM living with HIV | depression, polysubstance use, sexual risk behaviors | adherence to antiviral medication, viral load | regression analysis using a summation score, mediation analysis, Structural Equation Modeling | In this longitudinal study, the sum of syndemic conditions was associated with lower ART adherence and higher viral load among MSM living with HIV. Furthermore, the effect of syndemic conditions on viral load was partially mediated by ART adherence. |
| **Friedman et al. 2016** | USA | Longitudinal (72 months) | MSM living with HIV | depression, polysubstance use, sexual risk behaviors | adherence to antiviral medication, viral load | regression analysis using a summation score, moderation analysis | Among MSM living with HIV, functional social support moderates the effect of syndemic conditions on viral load suppression, providing a significant protective effect |
| **Guadamuz et al. 2014** | Thailand | Longitudinal (3.8 year) |  | substance use, suicidality, alcohol use, exchange sex, poor social support, violence | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | A higher number of syndemic conditions was significantly associated with greater odds of condomless anal sex, a higher HIV prevalence and a higher HIV incidence |
| **Halkitis et al. 2012** | USA | Mixed (cross-sectional quantitative method and discovery interview) | Older MSM living with HIV | depression, substance use, PTSD, alcohol use | engaging in sexual risk behaviors | regression analysis using a summation score | High prevalence of psychiatric conditions (PTSD and depression) as well as substance use among older MSM living with HIV. These psychosocial burdens are associated with unprotected anal intercourse. |
| **Halkitis et al. 2013** | USA | Cross-sectional | Young MSM | depression, substance use, PTSD, suicidality, alcohol use, sexual risk behaviors, loneliness |  | Structural Equation Modeling | A second-order model consisting of drug use and mental health burden was associated with a first-order model for unprotected sex, both indicated by numerous variables |
| **Halkitis et al. 2015** | USA | Longitudinal (36 months) | Young MSM | depression, substance use, PTSD, suicidality, alcohol use, sexual risk behaviors, loneliness |  | Confirmatory Factor Analysis | There was an increased use of substance and sexual risk behaviors with increasing age of this cohort of YMSM. Furthermore, the relative contribution of the syndemic indicator variables on the latent constructs varied accros time while still loading onto one latent construct across the four time points |
| **Harkness et al. 2018** | USA | Longitudinal (12 months) | MSM living with HIV | depression, substance use, PTSD, binge drinking, anxiety, CSA, polysubstance use | adherence to antiviral medication | regression analysis using a summation score | Participants' average syndemic score over the 12 months period predicted their non-adherence scores but not the time-specific changes in their average level. Furthermore, the effects of syndemic conditions on viral load may be mediated by non-adherence. |
| **Harkness et al. 2019** | USA | Longitudinal (12 months) | MSM living with HIV | depression, substance use, PTSD, binge drinking, anxiety, CSA, polysubstance use | engaging in sexual risk behaviors | regression analysis using a summation score | Syndemic score significantly predicted serodiscordant CAS and this effect was attributable to variation in score within person during the study as well as variation of mean score between participants |
| **Hart et al. 2017** | Canada | Longitudinal (6 months) |  | depression, CSA, polysubstance use, discrimination | engaging in sexual risk behaviors | regression analysis using a summation score | Psychosocial strengths were associated with a lesser odds of engagement in condomless anal sex, despite the presence of syndemic conditions. Psychosocial strenghts may operate in the same way as syndemic conditions but in an opposite direction. |
| **Herrick et al. 2013** | USA | Cross-sectional | MSM living with HIV | depression, substance use, IPV, sexual compulsivity, stress | syndemic conditions as the outcomes | hierarchical negative binomial regression | In this life-course approach of syndemic production among MSM, current forms of adversity (i.e. event discrimination, current marginalization and general life satisfaction) accounted for the largest contribution to the model while early life events also contributed significantly with childhood victimization and self-perception of failing masculinity attainment remaining significantly associated to the syndemic outcome variable after controlling for all other factors |
| **Herrick et al. 2014** | USA | Longitudinal (24 months) | Young MSM | depression, substance use, binge drinking | engaging in sexual risk behaviors | regression analysis using a summation score, mediation analysis | A greater number of syndemic conditions was associated with increased odds of sexual risk behaviors. Furthermore, experiences of adversity play an important role in syndemic formation and syndemic conditions mediate the pathway from adversity to sexual risk behaviors |
| **Hirshfield et al. 2015** | USA | Cross-sectional |  | depression, polysubstance use, incarceration, alcohol use | engaging in sexual risk behaviors | regression analysis using a summation score | MSM with encounters with 4 or more partners constitute a particularly high risk subgroup of MSM, with more condomless anal sex, polysubstance use, STI diagnosis and HIV prevalence. Furthermore, a higher count of syndemic conditions was associated with odds of participating in encounters with 4 or more partners. |
| **Hugh Klein 2011** | USA | Cross-sectional |  | depression, substance use, low self-esteem | engaging in sexual risk behaviors | Structural Equation Modeling | Emotional neglect in childhood and demographic factors influenced self-esteem which, in turn, along with substance use and several demographic and psychological functioning variables, influenced attitudes toward condom. This last variable predicted engagement in condomless anal and oral sex |
| **Jiang et al. 2020** | China | Cross-sectional |  | depression, IPV, CSA, chemsex | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score, Relative Excess Risk due to Interaction (RERI), moderation analysis | Depression and use of rush popper before sexual intercourse interacted to increase the number of sexual partners. CSA and use of rush popper before sexual intercourse interacted to increase the risk of HIV infection. Neither education nor income moderated the effects of syndemic factors on sexual risks taking or HIV infection |
| **Jie et al. 2012** | China | Cross-sectional |  | depression, IPV, binge drinking, CSA, polysubstance use | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score, mediation analysis | Experiencing a greater number of syndemic conditions was associated with sexual risk behaviors and HIV infection and the relationship between syndemic conditions and HIV infection seems to be partially mediated by sexual risk behaviors |
| **Kurtz et al. 2012** | USA | Cross-sectional | disagregated data for MSM living with HIV | substance use disorder, violence, cognitive escape, general mental distress | engaging in sexual risk behaviors | multivariate logistic regression | Serosorting among MSM living with HIV was positively associated with lower levels of cognitive escape and higher levels of two resilience factors : coping self-efficacy and positive coping skills. Among HIV-negative men, serosorting was positively associated with lower levels of cognitive escape, violence victimization and severe mental distress as well as with higher levels of coping self-efficacy and social engagements and with lower levels of negative coping skills |
| **Lee et al. 2020a** | USA | Cross-sectional |  | depression, substance use, IPV, binge drinking, suicidality, sexual compulsivity, anxiety, IDU, CSA |  | Exploratory Factor Analysis, Network Analysis | Network analysis is a valuable methodology to examine patterns of synergistic relationships among psychosocial conditions that form a syndemic and may be preferable to EFA. Suicidal ideation, IDU, substance use and depression were the four most central nodes, suggesting that they may be important psychosocial syndemic indicators to investigate as well as targets of intervention |
| **Lee et al. 2020b** | USA | Cross-sectional | Latino MSM | depression, substance use, IPV, IDU, CSA, incarceration, unstable housing, poverty, alcohol use | engaging in sexual risk behaviors | Network Analysis | Network analysis is feasible for studying syndemics. CAS and alcohol use were significantly associated as well as CSA and alcohol use, non-injection substance use and IPV. The four most central nodes were unstable housing, incarceration, CSA and CAS |
| **Li et al. 2016** | China | Cross-sectional |  | depression, substance use, sexual compulsivity, anxiety, sexual risk behaviors, poor social support, loneliness, involuntary subordination, low self-esteem, impulsivity | suicidality | regression analysis using a summation score | A higher number of syndemic conditions was associated with greater suicidal ideation among MSM, especially when the number of syndemic conditions reaches five. Among these conditions, only involuntary subordination and sexual risk taking remained significant in multivariate analysis |
| **Martinez et al. 2016** | USA | Cross-sectional | Latino MSM | depression, binge drinking, CSA, discrimination | engaging in sexual risk behaviors | regression analysis using a summation score | 90% of this sample of Latino MSM reported at least one syndemic condition and having a greater number of syndemic conditions was associated with higher odds of CAS and multiple sexual partners |
| **Martinez et al. 2020** | USA | Cross-sectional | Latino MSM | binge drinking, exchange sex, discrimination | engaging in sexual risk behaviors | regression analysis using a summation score | Having 2 or more syndemic conditions increased the number of male partners and CAS with casual partners in this sample of Latinx MSM in Philadelphia |
| **McDaid et al. 2019** | International | Cross-sectional |  | depression, IPV, suicidality, anxiety, STI, poor physical health | syndemic conditions as the outcomes | observed/expected ratio | Syndemic indicators of poor physical, mental and sexual health cluster and are partly influenced by a pathogenic social context and salutogenic community assets |
| **Mimiaga et al. 2015a** | Latin America | Cross-sectional |  | depression, IPV, suicidality, sexual compulsivity, CSA, AUD, chemsex | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | he number of syndemic conditions was associated with higher odds of engaging in CAS and self-report of HIV diagnosis |
| **Mimiaga et al. 2015b** | USA | Longitudinal (48 months) |  | depression, substance use, binge drinking, CSA, polysubstance use | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score, mediation analysis | In this longitudinal study, experiencing a greater number of syndemic conditions was associated with higher odds of HIV seroconversion over the 4-years follow-up and this effect was partially mediated by sexual risk behaviors |
| **Moeller et al. 2011** | USA | Cross-sectional |  | depression, substance use, anxiety, hostility | engaging in sexual risk behaviors | regression analysis using a summation score | A greater number of syndemic conditions was associated with condomless anal sex with both HIV-positive and HIV-negative partners but not with HIV status |
| **Morrison et al. 2018** | Canada | Cross-sectional |  | depression, sexual compulsivity, AUD, substance use disorder | engaging in sexual risk behaviors | regression analysis using a summation score, significant product term in regression | MSM seeking PEP in this sample were affected by a high burden of syndemic conditions. Furthermore, the number of syndemic conditions in an individual was associated with an increased HIV risk |
| **Muñoz-Laboy et al. 2018** | USA | Cross-sectional | Latino Men who have Sex with Men and Women | depression, CSA, polysubstance use | engaging in sexual risk behaviors, STI diagnosis | regression analysis using a summation score | Among this sample of LMSMW, having at least 2 syndemic conditions predicted lifetime STI and condomless receptive anal sex but not condomless insertive anal sex nor condomless vaginal sex |
| **Mustanski 2014** | USA | Cross-sectional | Young MSM, disagregated data for Men who have Sex with Men and Women | depression, substance use, IPV, binge drinking, sexual risk behaviors | suicidality | Structural Equation Modeling, Confirmatory Factor Analysis | Experiences of victimization and bullying increased the syndemic burden of all youths and subsequently syndemic burden increased suicide attempts. These findings held true for young men who have sex with women (YMSW), young men who have sex with men (YMSM) and young men who have sex with men and women (YMSMW). However, these relationships were much stronger among sexual minority youths and syndemic conditions clustered with particular strength among YMSMW |
| **Mustanski et al. 2007** | USA | Cross-sectional | Young MSM | substance use, IPV, binge drinking, violence, general mental distress | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | Experiencing a greater number of syndemic conditions was associated with higher odds of condomless anal sex, multiple sex partners and reported positive HIV status |
| **Mustanski et al. 2017** | USA | Longitudinal (12 months) | Young MSM, disagregated data for Black & Latino MSM | depression, IPV, binge drinking, suicidality, CSA, polysubstance use, AUD, discrimination | engaging in sexual risk behaviors, HIV diagnosis, STI diagnosis | Structural Equation Modeling | The study found evidence of a predictive ability of syndemic factors on sexual risk behaviors but there were no association with HIV/STI incidence. Furthermore, Black YMSM had both the highest seroconversion rate in the sample and a lesser burden in syndemic conditons compared to White and Latino YMSM, questioning the usefulness of syndemic theory on Black MSM or the need to take into account other syndemic conditions to explain the high rates of HIV acquisition among Black MSM |
| **Ng et al. 2020** | Malaysia | Cross-sectional | disagregated data for MSM living with HIV | depression, IPV, suicidality, CSA, chemsex | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | In this sample of Malaysian MSM, condomless anal sex was associated with depression and chemsex while self-reported HIV status was associated with depression, suicidal risk, chemsex and a history of CSA. Furthermore, self-reported HIV status was associated with the number of syndemic conditions |
| **Nostlinger et al. 2020** | Belgium | Longitudinal (18 months) |  | depression, substance use | engaging in sexual risk behaviors | regression analysis using a summation score, significant product term in regression | There was an interaction effet of recreational effect and drug use, potentiating sexual risk behaviors at baseline but not at 9 months or 18 months follow-up |
| **O'Leary et al. 2014** | USA | Cross-sectional | Black MSM | depression, IPV, CSA, AUD, substance use disorder | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | Experiencing a higher number of syndemic conditions was associated with greater odds of engaging in condomless anal sex and a higher prevalence of self-reported positive HIV status. Optimism and education buffered the relationship between syndemic conditions and self-reported HIV status but other resilience factors (connection to gay community, religiosity, Black pride and income) did not. Furthermore, none of the resilience factors buffered the relationship between syndemic conditions and sexual risk behaviors |
| **OCleirigh et al. 2018** | USA | Cross-sectional |  | substance use, IPV, suicidality, CSA | HIV diagnosis, healthcare use | regression analysis using a summation score | Experiencing syndemic conditions was associated with an increase in medical visits, medical costs and odds of self-reporting a positive HIV status |
| **Oginni et al. 2019** | Nigeria | Cross-sectional |  | depression, substance use, IPV, suicidality, alcohol use, tobacco use, childhood abuse | engaging in sexual risk behaviors | regression analysis using a summation score | Compared to straight men, MSM had greater odds of having experienced childhood adversity, IPV, depressive symptoms and suicidal thoughts. Furthermore experiencing a greater number of syndemic condition was associated with higher odds of engaging in sexual risk behaviors |
| **Ogunbajo et al. 2019** | Nigeria | Cross-sectional |  | depression, substance use, PTSD, AUD, tobacco use | engaging in sexual risk behaviors | regression analysis using a summation score | Association between PTSD and alcohol dependence as well as between alcohol dependence and hard drug use. The number of syndemic conditions was associated with a greater number of male partners but not with inconsistent condom use |
| **Pantalone et al. 2018** | USA | Cross-sectional | MSM living with HIV | IPV, suicidality, CSA, polysubstance use | adherence to antiviral medication, engaging in sexual risk behaviors, healthcare use | regression analysis using a summation score | In this sample of MSM living with HIV, the number of syndemic conditions was associated with ART adherence, having one syndemic condition was associated with inpatient medical admissions in the past year. Serodiscordant condomless anal sex was not associated with the syndemic count variable |
| **Parsons et al. 2012** | USA | Cross-sectional |  | depression, IPV, sexual compulsivity, CSA, polysubstance use | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | Sexual compulsivity was significantly associated with depression and IPV in multivariate analysis, as well as with self-reported positive HIV status and serodiscordant condomless anal sex. Furthermore, experiencing a greater number of syndemic conditions was associated with higher odds of engaging in sexual risk behaviors and reporting a positive HIV status |
| **Parsons et al. 2015** | USA | Cross-sectional |  | depression, IPV, sexual compulsivity, CSA, polysubstance use, hypersexuality | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score, mediation analysis | In this sample of highly sexually active MSM, sexual compulsivity and hypersexuality seemed to act as a syndemic condition associated with an increase in HIV risk rather than as a mediator of syndemic conditions on HIV risk. Furthermore, these findings provide support for a three group conceptualization of hypersexuality and sexual compulsivity (one, both or none) |
| **Parsons et al. 2017** | USA | Cross-sectional |  | depression, IPV, sexual compulsivity, CSA, polysubstance use | engaging in sexual risk behaviors | regression analysis using a summation score | Among a U.S. national sample of MSM, the sum of syndemic conditions was associated with greater likelihood of reporting sexual risk behaviours. Furthermore, MSM living in non-urban areas were more likely to experience sexual compulsivity. |
| **Perry et al. 2019** | USA | Cross-sectional | Adolescent MSM | substance use, CSA, AUD, general mental distress | engaging in sexual risk behaviors | regression analysis using a summation score | Syndemic conditions emerge early in the lifespan and are associated with early sexual experiences. Internalizing symptoms, problematic alcohol use, CSA and marijuana use were highly prevalent and interrelated. |
| **Pitpitan et al. 2016** | Mexico | Cross-sectional |  | depression, substance use, sexual compulsivity, internalised homophobia, violence | engaging in sexual risk behaviors | regression analysis using a summation score, moderation analysis | The number of syndemic conditions was associated with higher odds of engaging in condomless anal sex with a stranger. This effect was more pronounced in MSM who are out to less than 50% of their acquaintances |
| **Quinn et al. 2020** | USA | Longitudinal (18 months) | Latino MSM | incarceration, unstable housing, unemployment, poor healthcare access | engaging in sexual risk behaviors, viral load | regression analysis using a summation score | Experiencing structural syndemic conditions was associated with more sexual risk behaviors, both from HIV-positive and HIV-negative participants as well as with a detectable viral load among HIV-positive participants |
| **Reisner et al. 2016** | USA | Cross-sectional | Transgender MSM | depression, IPV, binge drinking, anxiety, CSA, polysubstance use, childhood abuse | engaging in sexual risk behaviors, STI diagnosis | regression analysis using a summation score, moderation analysis | In this sample of transgender MSM, syndemic conditions were associated with higher odds of engaging in condomless vaginal and/or anal sex and this association was fully moderated by social gender affirmation, suggesting similar sexual risk patterns for TMSM who have socially afirmed their gender identity as for cisgender MSM |
| **Safren et al. 2018** | USA | Longitudinal (6 months) |  | depression, IPV, sexual compulsivity, anxiety, CSA, AUD, substance use disorder | engaging in sexual risk behaviors | regression analysis using a summation score, mediation analysis | Cross-sectional analysis showed an indirect effect of syndemic conditions on condomless sex through lowered condom self-efficacy. However, a full longitudinal model was not supported by the data as changes in condom self-efficacy was not associated with changes in condomless sex |
| **Santos et al. 2014** | International | Cross-sectional |  | depression, substance use, unstable housing, discrimination, poor healthcare access, violence | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | Experiencing a higher number of syndemic conditions was associated with higher odds of engaging in condomless anal sex and self-reported positive HIV status |
| **Scheer et al. 2021** | USA | Cross-sectional |  | suicidality, polysubstance use, AUD, HIV | engaging in sexual risk behaviors | Latent Class Analysis/Latent Profile Analysis | Four classes of syndemic conditions were identified and class membership was associated with HIV risk behaviors. Notably, the MSM concurrently engaging in polysubstance use and living with HIV engaged in more HIV risk behaviors while MSM presenting higher levels of alcohol misuses demonstrated reduced HIV risk behaviors. |
| **Semple et al. 2017** | Mexico | Cross-sectional |  | depression, substance use, PTSD, sexual compulsivity, CSA, AUD, discrimination, sexual risk behaviors, hostility | having experienced sexual violence | multivariate linear regression | There is a high reported frequency of sexual violence among MSM in Tijuana. Furthermore, the authors suggest a model of co-occurring psychosocial factors such as CSA, adult homophobia, depressive symptoms and hostility that increase the odds of sexual violence experiences among MSM |
| **Shuper et al. 2020** | Canada | Cross-sectional |  | depression, substance use, AUD | PrEP-related outcomes | regression analysis using a summation score, significant product term in regression | Problematic alcohol use and cocaine use were found to be additively associated with PrEP nonadherence but no synergy were found between these two conditions. Furthermore, depression was not shown to be associated with PrEP nonadherence in this sample |
| **Stall et al. 2003** | USA | Cross-sectional |  | depression, IPV, CSA, polysubstance use | engaging in sexual risk behaviors, HIV diagnosis | regression analysis using a summation score | A greater number of syndemic conditions was associated with positive HIV status and sexual risk behaviors |
| **Starks 2014** | USA | Cross-sectional |  | depression, IPV, sexual compulsivity, CSA, polysubstance use |  | Latent Class Analysis/Latent Profile Analysis, Confirmatory Factor Analysis | In this study, constraining factor loadings to be equal, as it is done with summary score of syndemic conditions, significantly reduced model fit. In the other hand, a latent class analysis produced two ordinal categories of low syndemic burden and high syndemic burden, which is consistent with an underlying unidimensional syndemic stress factor |
| **Starks et al. 2016** | USA | Cross-sectional |  | depression, IPV, sexual compulsivity, CSA, polysubstance use | engaging in sexual risk behaviors | regression analysis using a summation score | The sum of syndemic conditions experienced by the partners in a couple was associated with condomless sex during first sexual intercourse and with non-disclosure of HIV status prior to first condomless anal sex |
| **Storholm et al. 2011** | USA | Cross-sectional | Young MSM | substance use, alcohol use, tobacco use, sexual risk behaviors, chemsex |  | point-biserial correlation | YMSM who reported smoking cigarettes were more likely to use marijuana, cocaine, inhalant nitrates, ecstasy, methamphetamine, hallucinogens, Adderall/Ritalin without prescription and to use alcohol until intoxication. Furthermore, they were also more likely to ingage in sexual risk behaviors such as use of substance before or during sex |
| **Sullivan and Eaton 2020** | USA | Cross-sectional | Black MSM | depression, substance use, AUD, exchange sex | PrEP-related outcomes | regression analysis using a summation score | MSM with a lower socio-economical status were less likely to be aware of PrEP and experiencing multiple syndemic conditions was associated with reduced odds of using PrEP although, taken independently, these conditions were not associated with PrEP use |
| **Tan et al. 2016** | Canada | Case series |  | depression, AUD, substance use disorder |  | no interaction studied | A high burden of mental health problem was found in this sample of MSM PrEP Users. Using self-administered questionnaire was a feasible and useful strategy for screening those conditions |
| **Tomori et al. 2018** | India | Cross-sectional |  | depression, substance use, IPV, CSA, AUD | engaging in sexual risk behaviors, STI diagnosis | regression analysis using a summation score, Relative Excess Risk due to Interaction (RERI) | There is an additive relationship between the count of syndemic conditions and condomless sex but not with syphilis. As for interaction, RERI were significant only for IPV and depression for condomless anal sex and for alcohol dependence and substance use for syphilis |
| **Tulloch et al. 2015** | Canada | Cross-sectional |  | depression, IPV, polysubstance use | engaging in sexual risk behaviors | regression analysis using a summation score, mediation analysis | The number of syndemic conditions mediated the relationship between childhood physical abuse and sexual risk as well as between verbal victimization and sexual risk |
| **Turpin et al. 2020a** | USA | Cross-sectional | Young MSM | depression, substance use, IPV, bullying, violence | engaging in sexual risk behaviors | Latent Class Analysis/Latent Profile Analysis | A syndemic of victimization, sexual violence, IPV, substance use and depression was identified in a latent profile comprising 1/8th of the sample. This profile was strongly associated with substance use at last sexual intercourse and number of partners but not with condom use. |
| **Turpin et al. 2020b** | USA | Longitudinal (12 months) | Black MSM | depression, substance use, IPV, internalised homophobia, discrimination, poor social support, experience of trauma | substance use | Latent Transition Analysis | Using latent transition analysis, three profiles of high-risk syndemic status with different proportions of syndemic factors and a low risk profile were identified. Moreover, social support strongly moderated the association between these profiles and substance use at 12 months in that BMSM with better social support had more chance to stay in the low risk profile or to transition from high risk to low risk. |
| **Vanden Berghe et al. 2014** | Belgium | Cross-sectional |  | depression, sexual risk behaviors, chemsex | engaging in sexual risk behaviors | moderation analysis | Depressive symptoms and sexual sensation seeking were more present in MSM who engaged in condomless anal sex in the past 6 months while use of alcohol or substance or alcohol just before or during sex was not. However, this study found no evidence that depressive symptoms moderated the effect of risk perception of condomless anal sex on engaging in condomless anal sex. |
| **Walters et al. 2020** | USA | Cross-sectional | MSM living with HIV | depression, IPV, polysubstance use | engaging in exchange sex | regression analysis using a summation score | Exchange sex was associated with being a Black MSM, < 30 years, annual incomes < 20.000$, recent depressive symptoms, polydrug use, stimulant use and having experienced past and present IPV |
| **Wang et al. 2017** | China | Cross-sectional |  | depression, sexual compulsivity, anxiety, loneliness, low self-esteem | engaging in sexual risk behaviors | regression analysis using a summation score | In this sample of MSM living in China, a significant proportion of respondent had at least two syndemic conditions which was associated with higher odds of engaging in condomless anal sex |
| **Wang et al. 2018** | China | Cross-sectional |  | depression, sexual compulsivity, anxiety, poor social support, loneliness, involuntary subordination, low self-esteem | engaging in sexual risk behaviors | regression analysis using a summation score | Syndemic conditions are additively associated with multiple sex partners |
| **Wu Elwin 2018** | USA | Cross-sectional | Black MSM | substance use, IPV, binge drinking, CSA, sexual risk behaviors |  | regression analysis using a summation score | CSA is an important antecedent in the formation of a syndemic in black MSM in the USA |
| **Yu et al. 2013** | China | Cross-sectional |  | depression, substance use, IPV, alcohol use, tobacco use | engaging in sexual risk behaviors | multivariate linear regression | High prevalence of smoking was found in this sample of Chinese MSM and the level of smoking was associated with alcohol use, substance use and depressive symptoms. Furthermore, sexual risk taking was positively associated with smoking, alcohol use, substance use and IPV |
| **Zepf et al. 2020** | USA | Cross-sectional | Older MSM living with HIV | depression, substance use, PTSD, IPV, binge drinking, violence | adherence to antiviral medication | regression analysis using a summation score | Experiencing syndemic conditions is associated with decreased medication adherence ; PTSD and stiulant use had the strongest influence on medication adherence in the final model. |
| **Zhang et al. 2019** | USA | Longitudinal (12 months) | Black MSM | depression, IPV, CSA, AUD, unemployment, substance use disorder | physical activity | regression analysis using a summation score, moderation analysis | Number of syndemic conditions at baseline predicted lower levels of physical activity. No synergistic interaction was found. No evidence of a moderating effect of resilience on the relationship between syndemic conditions and physical activity |

Table 3: Reference table of the included qualitative studies

| **References** | **Location** | **Analysis method** | **Subpopulation** | **Bio-social interaction** | **Key findings** |
| --- | --- | --- | --- | --- | --- |
| **Adam et al. 2017** | Canada | thematic analysis |  |  | Life story interviews of MSM affected by at least two syndemic conditions revealed one major pathway of syndemic production (childhood adversity leading to depression, substance abuse and risk taking) and two minor modes characterised by migration stress or transition stress from home to college or work. Furthermore, risk practice fell into different subjectivities (active and consistent pursuit of condomless sex, lack of assertiveness to a partner's initiative of CAS and combination of risk reduction strategies) |
| **Adam et al. 2018** | Canada | comparative |  |  | Some of the men interviewed in this study found safety from family in school but a more sizeable part encoutered bullying which compounded their distress at home. Furthermore, some found refuges from hostile home and school environment through books, pop culture and internet chat. Finally, during adolescence a subset of men experienced sexual relationships with older men who brought emotional stability and personal growth |
| **Bruce et al. 2011** | USA | thematic analysis, cross case analysis | Young MSM living with HIV |  | The results of this study suggests links between experiences of marginalization in childhood/aolescence and subsequent search for gay peers and migration to larger city and/or gay neighboorhood. This migration exposes YMSM to a range of risk factors such as experimentation with substance and sex. Compared to straight youth, this risk may be heightened due to lack of support. On the other hand, access to gay spaces also offers resilience resources such as a sense of community and peer support. |
| **Cassels et al. 2020** | USA | thematic analysis | Latino & Black MSM |  | Geographic mobility represents a syndemic condition in itself as it was found to magnify many HIV risk factors such as racism, lack of social cohesion or place attachement, barriers to HIV care and high-risk sexual encounters. When, geographic mobility was tied with housing instability, its direct contribution to the syndemic was found to be above and beyond its role in housing insecurity |
| **Chakrapani et al. 2019** | India | framework analysis |  | Multiple forms of intersecting stigma (i.e. same-sex sexuality, gender non-conformity, sex work and socio-economic stigmas) contribute to the production of syndemic conditions (i.e. depression, suicidality, internalized homonegativity, violence and problematic alcohol use as a coping strategy) which in turn increase HIV risk. Family support and communities of MSM may serve as a resilience resource and counteract the negative effects of stigma and syndemic conditions. | Intersecting stigma related to same-sex attraction, gender non-conformity and sex work contribute to the production of syndemic conditions which may in turn increase sexual risk behaviors. Family and community of MSM may serve as resilience and counteract the effects of stigma and syndemic conditions |
| **Lyons et al. 2013** | USA | grounded theory | Young MSM living with HIV | The marginalization of YMSM within their school, communities of origin and families result in a lack of gay-specific HIV prevention education, role model and productive goal-related activities, all of them being linked to HIV infection. | Alcohol use, substance use, marginalization, family rejection, lack of social support and lack of gay-specific HIV prevention as well as role models contributed to the HIV infection in YMSM. |
| **Maionara et al. 2020** | USA | thematic analysis | Young Black MSM | Economic dependency and fear of violence may maintain YBMSM in dysfunctional relationships plagued by intimate partner violence and substance abuse which increase their odds of incarceration and HIV infection. Their criminal records may then prevent YBMSM from achieving formal employment. Methamphetamine is a way of coping with this structural violence and eventual HIV diagnosis but represents a potential factor in transmitting HIV to others, notably during sex parties. | Methamphetamine use, intimate partner violence and incarceration may form a syndemic in the lives of young black men who have sex with men, increasing their vulnerability of acquiring or transmitting HIV |
| **Pollard et al. 2018** | England | framework analysis |  | Maladaptive coping strategies to minority stress and the performative resistant space of the gay scene contribute to chemsex use and HIV risks | The experience of chemsex and HIV-risk is entangled in complex narratives in which drug use is related to marginalisation, loneliness and a gay scene that acted both as a space of personal affirmation and resistance and as a barrier to fulfilling psychosocial needs such as meaningful emotional conections. |
| **Quinn 2019** | USA | thematic content analysis | Black MSM | Intersectional structural violence (e.g. racial neighborhood segregation, poverty, unemployment, violence, unstable housing, incarceration and poor healthcare access) leads to expectations surrounding masculinity which conflicts with the sexual orientation of BMSM and results in internalized homophobia. Internalized homophobia, in turn, produce poor mental health, suicidal ideation as well as substance abuse and sexual risk taking as a coping mechanism. Furthermore, the use of PrEP, perceived as a “gay pill” is less often considered. This all leads to an increase in HIV infection. | Intersectionality provides the context needed to understand syndemics among BMSM, which differs from syndemics among white MSM due to intersecting stigma and harmful social conditions unique to BMSM. These structural inequities, notably racial neighborhood segregation, shape the expectations surrounding masculinity, which result in societal and internalized homophobia, producing distress, depression, suicidal ideation, substance use and HIV risk behavior. |
| **Reed et al. 2016** | USA | analytic induction | Young Black MSM |  | Young Black MSM experimenting syndemic conditions have more conflicted identities, notably between their racial and sexual identities, and are disconnected both from their family and the gay community. Sense of community may thus be an important mediator between adversity and syndemics |

Table 4: Reference table of the included reviews

| **References** | **Design** | **Purpose of the review** | **Number of included studies** | **Key findings** |
| --- | --- | --- | --- | --- |
| **Lassiter et al. 2016** | Systematic review | Examining the effects of spirituality and religion on MSM's health and proposing a framework for integrating these factors into HIV research with MSM | 9 | Religion and spirituality have mixed effect on syndemic conditions of MSM but may be more beneficial for the health of MSM of color than for white MSM. All in all, religion and spirituality was completey absent from syndemic quantitative research and very sparse in syndemic conditions research focused on MSM |
| **Lewis and Wilson 2017** | Systematic review | Examine the HIV prevalence and associated risk behaviours among migrant and ethnic minority MSM in North America and Europe | 24 | Ethnic minority MSM are faced with high rates of HIV prevalence and associated risk factors such as substance use and condomless anal sex. Furthermore, the high prevalence of these factors in samples comprised mostly or entirely of immigrant MSM gives credit to the hypothesis that transational migration is part of a syndemic. |
| **Pantalone et al. 2020** | Systematic review and meta-analysis | To have a better understanding of the state of interventions co-targeting interrelated syndemic conditions and HIV-related health behaviors of sexual minority men | 43 | The meta-analysis showed a small significant positive effect of combined behavioral interventions to improve syndemic conditions (mental health, drug and alcohol use ; d=0.20) and sexual risk behaviors (d=0.16) with significant heterogeneity. More sessions (9 or more) and individual rather than group interventions showed grater efficacy. |
| **Rooney et al. 2018** | Meta-analysis | (1) Determine which syndemic conditions are significantly associated with sexual compulsivity among MSM ; (2) calculate the mean effect size of these conditions with sexual compulsivity; (3) determine if this effect varies as a function of the type of syndemic condition | 36 | Sexual compulsivity was significantly associated with 7 syndemic indicators (anxiety, depression, childhood sexual abuse, alcohol use, substance use, interpartner violence and sexual risk. The two strongest associations were with depression and anxiety |
| **Woodward et al. 2016** | Systematic review | Identify a set of resilience ressources among MSM burdened with minority stress and psychosocial conditions which may improve HIV prevention | 20 | 31 resilience ressources were identified, with the most frequently cited being social support and incomes. Most of these resources were associated with a lower HIV risk. |

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## C. Measurement tables

Table 5: Summary of the studies including depression or depressive symptoms as a syndemic condition and the criteria used to screen this condition

| **Use of a scale or a criteria** | **Number of studies** | **Scale or criteria used** | **Number of studies** | **Cutoff used** | **References** |
| --- | --- | --- | --- | --- | --- |
| Scale | 66 | CESD | 24 | 16 | **Zhang et al. 2019** |
| **Morrison et al. 2018** |
| **Wang et al. 2017** |
| **Friedman et al. 2016** |
| **Tulloch et al. 2015** |
| **Friedman et al. 2015** |
| **Herrick et al. 2014** |
| **Herrick et al. 2013** |
| **Dyer et al. 2012** |
| **Tan et al. 2016** |
| **Ng et al. 2020** |
| 22 | **Vanden Berghe et al. 2014** |
| 23 | **Wang et al. 2018** |
| **Parsons et al. 2017** |
| **Hart et al. 2017** |
| **Li et al. 2016** |
| **Starks 2014** |
| **Jie et al. 2012** |
| **Parsons et al. 2012** |
| **Stall et al. 2003** |
| 27 | **Carrico et al. 2018** |
| Continuous | **Hugh Klein 2011** |
| **Turpin et al. 2020b** |
| **Dyer et al. 2020** |
| CESD-10 | 10 | 10 | **Chandler et al. 2020a** |
| **Ogunbajo et al. 2019** |
| **Chandler et al. 2020b** |
| **Martinez et al. 2016** |
| **Biello et al. 2016** |
| **Mimiaga et al. 2015a** |
| **Biello et al. 2014** |
| **Shuper et al. 2020** |
| **Chandler et al. 2020c** |
| **Sullivan and Eaton 2020** |
| PHQ-9 | 8 | 10 | **Zepf et al. 2020** |
| **Nostlinger et al. 2020** |
| **Harkness et al. 2019** |
| **Tomori et al. 2018** |
| 15 | **McDaid et al. 2019** |
| 5 | **Chakrapani et al. 2020** |
| **Safren et al. 2018** |
| Having at least 5 positive items in addition to the depressed mood and/or loss of interest items | **Harkness et al. 2018** |
| BDI-II | 5 | 16 | **Halkitis et al. 2012** |
| 17 | **Pitpitan et al. 2016** |
| Continuous | **Semple et al. 2017** |
| **Halkitis et al. 2015** |
| **Halkitis et al. 2013** |
| Depression subscale of the Brief Symptom Inventory | 4 | 0.5 (raw-score) | **Parsons et al. 2015** |
| 0.8 (raw score) | **Muñoz-Laboy et al. 2018** |
| 65 (T-score) | **Starks et al. 2016** |
| Not specified | **Moeller et al. 2011** |
| PHQ-2 | 3 | 3 | **Walters et al. 2020** |
| **Hirshfield et al. 2015** |
| **Santos et al. 2014** |
| PHQ-8 | 3 | 10 | **Blashill et al. 2020** |
| Continuous | **Lee et al. 2020a** |
| **Lee et al. 2020b** |
| HADS | 2 | 10 | **Card et al. 2018** |
| 8 | **Achterbergh et al. 2021** |
| Zung Self Rating Depression Scale | 2 | 0.5 | **Jiang et al. 2020** |
| 40 | **Oginni et al. 2019** |
| BDI-FS | 1 | 7 | **Chakrapani et al. 2017** |
| CESD-12 | 1 | 10 | **Yu et al. 2013** |
| CESD-5 | 1 | 1 | **O'Leary et al. 2014** |
| CESD-SF | 1 | 13 | **Mimiaga et al. 2015b** |
| The Depression Symptom Scale (DSS-9) | | | **Friedman et al. 2014** |
| Criteria | 10 | Being on medication for depression in the last 12 months | | | **Ferlatte et al. 2015** |
| **Brandstrom and Pachankis 2018** |
| **Ferlatte et al. 2018b** |
| Clinical diagnosis based on the DSM-IV | | | **Batchelder et al. 2019** |
| **Mustanski et al. 2017** |
| During the past 12 months having felt so sad or hopeless almost every day for 2 weeks in a row that the respondent stopped doing some usual activities | | | **Turpin et al. 2020a** |
| **Mustanski 2014** |
| Feeling snap and unable to snap out of it for most of the time or being in treatment for depression | | | **Ferlatte et al. 2014** |
| Medical diagnosis of depression in the EMR | | | **Byg et al. 2016** |
| Self-report of a medical diagnosis | | | **Reisner et al. 2016** |

Table 6: Summary of the studies including intimate partner violence as a syndemic condition and the criteria used to screen this condition

| **Use of a scale or a criteria** | **Number of studies** | **Type(s) of violence screened or scale used** | **Number of studies** | **Reference period or cutoff used** | **References** |
| --- | --- | --- | --- | --- | --- |
| Criteria | 38 | physical IPV, sexual IPV, psychological IPV | 12 | Past year | **Oginni et al. 2019** |
| Past 6 months | **Turpin et al. 2020b** |
| Past 5 years | **Biello et al. 2016** |
| **Starks et al. 2016** |
| **Mimiaga et al. 2015a** |
| **Parsons et al. 2015** |
| **Stall et al. 2003** |
| **Achterbergh et al. 2021** |
| Lifetime | **Lee et al. 2020a** |
| **Safren et al. 2018** |
| **Mustanski et al. 2007** |
| **Dyer et al. 2020** |
| physical IPV, psychological IPV | 8 | Past 5 years | **Starks 2014** |
| **Herrick et al. 2013** |
| **Dyer et al. 2012** |
| **Parsons et al. 2012** |
| Past 12 months | **McDaid et al. 2019** |
| **Ferlatte et al. 2018a** |
| Not specified | **Jie et al. 2012** |
| Lifetime | **Walters et al. 2020** |
| physical IPV | 7 | Past month | **Mustanski 2014** |
| Past 4 months | **Eaton et al. 2013** |
| Past 12 months | **Chandler et al. 2020a** |
| **Chandler et al. 2020b** |
| **Chandler et al. 2020c** |
| Lifetime | **Tomori et al. 2018** |
| **Tulloch et al. 2015** |
| physical IPV, sexual IPV | 6 | Past 6 months | **Mustanski et al. 2017** |
| Lifetime | **Turpin et al. 2020a** |
| **OCleirigh et al. 2018** |
| **O'Leary et al. 2014** |
| **Ng et al. 2020** |
| **Reisner et al. 2016** |
| physical IPV, sexual IPV, psychological IPV, gay-related IPV | 2 | Past 5 years | **Jiang et al. 2020** |
| Lifetime | **Chuang et al. 2018** |
| Not specified | 2 | Not specified | **Byg et al. 2016** |
| Lifetime | **Beymer et al. 2016** |
| physical IPV, sexual IPV, psychological IPV, gay-related IPV, HIV-related IPV | 1 | Past month | **Wu Elwin 2018** |
| Scale | 7 | HITS | 3 | Continuous | **Lee et al. 2020b** |
| 11 | **Zepf et al. 2020** |
| **Blashill et al. 2020** |
| CTS2 | 3 | Responding yes to at least one item | **Parsons et al. 2017** |
| Not specified | **Zhang et al. 2019** |
| Continuous | **Pantalone et al. 2018** |
| Authors' scale (physical and psychological) | 1 | continuous | **Yu et al. 2013** |
| Physical intimate partner violence: 36 studies ; 80% of studies with IPV as a syndemic condition | | | | | |
| Psychological intimate partner violence: 23 studies ; 51% of studies with IPV as a syndemic condition | | | | | |
| Sexual intimate partner violence: 21 studies ; 47% of studies with IPV as a syndemic condition | | | | | |
| Gay-related intimate partner violence: 3 studies ; 7% of studies with IPV as a syndemic condition | | | | | |
| HIV-related intimate partner violence: 1 studies ; 2% of studies with IPV as a syndemic condition | | | | | |

Table 7: Summary of the studies including substance use as a syndemic condition and the substances specifically screened in the studies

| **Type of substances screened** | **Number of studies** | **Reference period** | **References** |
| --- | --- | --- | --- |
| stimulants | 6 | Past month | **Zepf et al. 2020** |
| Past 6 months | **Mimiaga et al. 2015b** |
| **Herrick et al. 2013** |
| **Dyer et al. 2020** |
| Past 3 months | **Harkness et al. 2019** |
| **Harkness et al. 2018** |
| stimulants, ecstasy, hallucinogens, depressants | 4 | Past 4 months | **Moeller et al. 2011** |
| Past 12 months | **Ferlatte et al. 2015** |
| **Ferlatte et al. 2018a** |
| **Ferlatte et al. 2018b** |
| stimulants, marijuana, opioids | 3 | Past month | **Semple et al. 2017** |
| Past 3 months | **Wu Elwin 2018** |
| Lifetime | **Oginni et al. 2019** |
| stimulants, ecstasy, hallucinogens, marijuana, depressants, opioids, inhalants | 3 | Past month | **Halkitis et al. 2015** |
| **Halkitis et al. 2013** |
| Past 3 months | **Storholm et al. 2011** |
| stimulants, opioids | 2 | Past 6 months | **OCleirigh et al. 2018** |
| **Tomori et al. 2018** |
| not\_specified | 2 | Past month | **Biello et al. 2014** |
| Past 12 months | **Santos et al. 2014** |
| marijuana | 2 | Past month | **Blashill et al. 2020** |
| Lifetime | **Perry et al. 2019** |
| stimulants, marijuana, inhalants | 1 | Past 4 months | **Eaton et al. 2013** |
| stimulants, marijuana | 1 | Past month | **Mustanski 2014** |
| stimulants, inhalants | 1 | Past 3 months | **Sullivan and Eaton 2020** |
| stimulants, hallucinogens, marijuana, depressants, inhalants | 1 | Lifetime | **Shuper et al. 2020** |
| stimulants, hallucinogens, depressants, opioids, inhalants | 1 | Past 3 months | **Lee et al. 2020a** |
| stimulants, hallucinogens, depressants, opioids | 1 | Past month | **Lee et al. 2020b** |
| stimulants, hallucinogens, depressants, NPS, opioids | 1 | Lifetime | **Ogunbajo et al. 2019** |
| stimulants, hallucinogens, depressants, NPS | 1 | Past 3 months | **Nostlinger et al. 2020** |
| stimulants, ecstasy, opioids, inhalants | 1 | Past 6 months | **Dyer et al. 2012** |
| stimulants, ecstasy, NPS, opioids | 1 | Lifetime | **Turpin et al. 2020a** |
| stimulants, ecstasy, marijuana, depressants, opioids | 1 | **Yu et al. 2013** |
| stimulants, ecstasy, marijuana | 1 | **Li et al. 2016** |
| stimulants, ecstasy, inhalants | 1 | Past 12 months | **Beymer et al. 2016** |
| stimulants, ecstasy, hallucinogens, marijuana, depressants, opioids | 1 | Past month | **Hugh Klein 2011** |
| stimulants, ecstasy, hallucinogens, marijuana, depressants | 1 | Past 12 months | **Mustanski et al. 2007** |
| stimulants, ecstasy, hallucinogens, depressants, opioids, inhalants | 1 | Lifetime | **Pitpitan et al. 2016** |
| stimulants, ecstasy, hallucinogens, depressants, opioids | 1 | Past 3 months | **Herrick et al. 2014** |
| stimulants, ecstasy, hallucinogens, depressants, inhalants | 1 | Past 4 months | **Guadamuz et al. 2014** |
| stimulants, depressants, opioids, inhalants | 1 | Past 6 months | **Turpin et al. 2020b** |
| marijuana, opioids | 1 | Past 12 months | **Chakrapani et al. 2019b** |
| marijuana, inhalants | 1 | Past month | **Halkitis et al. 2012** |
| Stimulants : cocaine/crack, amphetamine (37 studies ; 86%) | | | |
| Ecstasy (17 studies ; 40%) | | | |
| Hallucinogens : ketamine, psilocybine, phencyclidine (17 studies ; 40%) | | | |
| Marijuana (17 studies ; 40%) | | | |
| Depressants : GHB/GBL, benzodiazebines (19 studies ; 44%) | | | |
| NPS : New Psychoactive Substances : synthetic cannabinoids, cathinones (3 studies ; 7%) | | | |
| Opioids : opioids misuse, heroin (19 studies ; 44%) | | | |
| Inhalants : nitrous oxyde, Popper : (13 studies ; 30%) | | | |

Table 8: Summary of the studies including childhood sexual abuse as a syndemic condition and the criteria used to screen this condition

| **Use of a scale or a criteria** | **Number of studies** | **Scale or criteria used1** | **Number of studies** | **Cutoff used** | **References** |
| --- | --- | --- | --- | --- | --- |
| Definition | 28 | Finkelhor definition | | | **Lee et al. 2020a** |
| **Blashill et al. 2020** |
| **Lee et al. 2020b** |
| **Harkness et al. 2019** |
| **Safren et al. 2018** |
| **Harkness et al. 2018** |
| **Mimiaga et al. 2015b** |
| Any unwanted sexual experience before 18 years old | | | **Semple et al. 2017** |
| **Biello et al. 2016** |
| **Starks et al. 2016** |
| **Mimiaga et al. 2015a** |
| **Biello et al. 2014** |
| **Ng et al. 2020** |
| Any unwanted sexual experience before 17 years old with someone at least 10 years older | | | **Parsons et al. 2015** |
| **Starks 2014** |
| **Parsons et al. 2012** |
| **Stall et al. 2003** |
| Any unwanted sexual experience before 15 years old | | | **OCleirigh et al. 2018** |
| **Reisner et al. 2016** |
| Having experienced unwanted sexual activity with someone older at 16 years old or younger | | | **Parsons et al. 2017** |
| Having experienced sexual abuse as a child | | | **Eaton et al. 2013** |
| Any unwanted sexual experience before 17 years old | | | **Martinez et al. 2016** |
| Any unwanted sexual experience before 16 years old with someone at least 5 years older | | | **Jie et al. 2012** |
| Any unwanted sexual experience before 16 years old | | | **Tomori et al. 2018** |
| Any unwanted sexual experience before 13 years old | | | **Mustanski et al. 2017** |
| Any sexual experience before 13 years old with someone at least 4 years older | | | **Muñoz-Laboy et al. 2018** |
| Any sexual experience before 12 years old, any unwanted sexual experience between 12 years old and 16 years old or any sexual experience with an adult or someone at least 5 years older before 16 years old | | | **Jiang et al. 2020** |
| Any sexual experience before 11 years old, any unwanted sexual experience between 11 years old and 17 years old or any sexual experience with someone at least 4 years older before 17 years old | | | **Wu Elwin 2018** |
| Scale | 6 | CTQ Sexual Abuse subscale | 3 | 5 | **Perry et al. 2019** |
| **Hart et al. 2017** |
| 13 | **Carrico et al. 2018** |
| WSHQ-CSA | 2 |  | **Zhang et al. 2019** |
| **O'Leary et al. 2014** |
| Sexual abuse subscale of the Childhood Maltreatment Interview Schedule - Short Form (CMIS-SF) | 1 | Endorsement of any one item | **Pantalone et al. 2018** |
| 1Finkelhor definition : any sexual experience before 13 years old with someone at least 5 years older or any sexual experience between 13 and 17 years old with someone at least 10 years older (Finkelhor 1994) | | | | | |

Table 9: Summary of the studies including polysubstance use as a syndemic condition and the criteria used to screen this condition

| **Number of substances to qualify as polysubstance use** | **Number of studies** | **Inclusion of marijuana in the substances count** | **Reference period** | **References** |
| --- | --- | --- | --- | --- |
| At least 3 categories of substance use | 16 | Marijuana not included | Past month | **Blashill et al. 2020** |
| Past 3 months | **Chandler et al. 2020a** |
| **Chandler et al. 2020b** |
| Past 12 months | **Pantalone et al. 2018** |
| Marijuana included | Past 6 weeks | **Parsons et al. 2015** |
| Past 6 months | **Card et al. 2018** |
| **Tulloch et al. 2015** |
| **Stall et al. 2003** |
| Past 4 months | **Muñoz-Laboy et al. 2018** |
| Past 3 months | **Harkness et al. 2019** |
| **Harkness et al. 2018** |
| **Parsons et al. 2017** |
| **Starks 2014** |
| **Parsons et al. 2012** |
| Past 2 months | **Hirshfield et al. 2015** |
| Past 12 months | **Reisner et al. 2016** |
| More than one category of substance use | 9 | Marijuana not included | Past 3 months | **Walters et al. 2020** |
| **Hart et al. 2017** |
| Marijuana included | Past 6 months | **Mustanski et al. 2017** |
| **Friedman et al. 2016** |
| **Friedman et al. 2015** |
| **Jie et al. 2012** |
| Past 3 months | **Starks et al. 2016** |
| **Scheer et al. 2021** |
| **Chandler et al. 2020c** |
| At least 3 categories of substance, excluding stimulants | 1 | Marijuana included | Past 6 months | **Mimiaga et al. 2015b** |

Table 10: Summary of the studies including binge drinking as a syndemic condition and the criteria used to screen this condition

| **Number of episodes to qualify as binge drinking** | **Number of studies** | **Reference period** | **References** |
| --- | --- | --- | --- |
| At least one episode | 12 | Past month | **Blashill et al. 2020** |
| **Martinez et al. 2020** |
| **Martinez et al. 2016** |
| **Herrick et al. 2014** |
| Past 6 months | **Mustanski et al. 2017** |
| **Jie et al. 2012** |
| **Dyer et al. 2012** |
| **Reisner et al. 2016** |
| **Dyer et al. 2020** |
| Past 3 months | **Lee et al. 2020a** |
| **Wu Elwin 2018** |
| Past 12 months | **Zepf et al. 2020** |
| At least one per week, every week | 4 | Past 3 months | **Harkness et al. 2019** |
| **Harkness et al. 2018** |
| Past 12 months | **Mustanski et al. 2007** |
| **Ferlatte et al. 2018b** |
| At least one per month | 2 | Past 12 months | **Chandler et al. 2020a** |
| **Chandler et al. 2020b** |
| More than one per week, every week | 2 | Past 12 months | **Brandstrom and Pachankis 2018** |
| **Ferlatte et al. 2018a** |
| At least 3 episodes | 1 | Past month | **Mustanski 2014** |
| Having at least 4 drinks everyday or at least 6 drinks on a typical drinking day | 1 | Not specified | **Mimiaga et al. 2015b** |

Table 11: Summary of the studies including violence as a syndemic condition and the criteria used to screen this condition

| **Type(s) of violence screened** | **Number of studies** | **violence\_period** | **References** |
| --- | --- | --- | --- |
| sexual | 5 | Past 4 months | **Eaton et al. 2013** |
| Lifetime | **Turpin et al. 2020a** |
| **Guadamuz et al. 2014** |
| **Biello et al. 2014** |
| **Mustanski et al. 2007** |
| physical, sexual, psychological | 4 | Past 12 months | **Friedman et al. 2014** |
| Lifetime | **Pitpitan et al. 2016** |
| **Buttram et al. 2015** |
| **Kurtz et al. 2012** |
| physical, sexual | 2 | Past 12 months | **Chakrapani et al. 2019b** |
| Lifetime | **Zepf et al. 2020** |
| physical | 2 | Past 12 months | **Chandler et al. 2020c** |
| Lifetime | **Brandstrom and Pachankis 2018** |
| physical, sexual harassment by police, physical harassment by police | 1 | Not specified | **Chakrapani et al. 2017** |
| physical, psychological | 1 | Past 12 months | **Santos et al. 2014** |
| Physical violence: 10 studies ; 22% of studies with violence as a syndemic condition | | | |
| Psychological violence: 5 studies ; 11% of studies with violence as a syndemic condition | | | |
| Sexual violence: 11 studies ; 24% of studies with violence as a syndemic condition | | | |
| Physical harassment by the Police: 1 studies ; 2% of studies with violence as a syndemic condition | | | |
| Sexual harassment by the Police: 1 studies ; 2% of studies with violence as a syndemic condition | | | |

Table 12: Summary of the studies including anxiety as a syndemic condition and the criteria used to screen this condition

| **Type of anxiety disorder screened, if specified** | **Number of studies** | **Criteria or scale used** | **Number of studies** | **Reference period or cutoff used** | **References** |
| --- | --- | --- | --- | --- | --- |
| not specified | 5 | Being on medication for anxiety | 2 | Past 12 months | **Ferlatte et al. 2015** |
| **Ferlatte et al. 2018b** |
| BSI | 1 | Not specified | **Moeller et al. 2011** |
| Self-report of having an anxiety disorder | 1 |  | **Reisner et al. 2016** |
| HADS | 1 | 8 | **Achterbergh et al. 2021** |
| generalized anxiety disorder | 4 | GAD-7 | 4 | 10 | **McDaid et al. 2019** |
| **Wang et al. 2018** |
| **Wang et al. 2017** |
| **Li et al. 2016** |
| social phobia, panic disorder, generalized anxiety disorder | 3 | MINI-SPIN, PHQ | 2 |  | **Harkness et al. 2019** |
| **Harkness et al. 2018** |
| Clinical diagnosis based on the DSM-IV | 1 | **Batchelder et al. 2019** |
| social phobia | 2 | SPIN | 2 | 19 | **Lee et al. 2020a** |
| **Safren et al. 2018** |