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The global distribution and epidemiology of alcohol and drug use among street-involved children and youth: a meta-analysis

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ABSTRACT

Background: Street-involved children and youth (SICY) who work and live on/of the streets are more likely to inject drugs and engage in psychoactive substance use.
Objectives: The present study aimed to identify the prevalence, distribution, sociodemographic determinants, and risk-taking associated with alcohol and drug use among SICY.
Methods: Studies published in English related to alcohol and drug use among SICY were searched for from December 1 1985 to July 1 2022, on *PubMed*, *Scopus*, *Cochrane*, and *Web of Science*.
Results: After full-text paper evaluation, 73 studies were included in the meta-analysis. Results indicated that lifetime prevalence rates were 44% (alcohol), 44% (crack), 33% (inhalants), 44% (solvents), 16% (tranquilizer/sedatives), 22% (opioids), and 62% (polysubstance use). The current prevalence rates were 40% (alcohol), 21% (crack), 20% (inhalants), 11% (tranquilizer/sedatives), and 1% (opioids). Also, life-time and current prevalence of alcohol and crack use, current prevalence of tranquilizer/sedative use, and life-time prevalence of polysubstance use were higher among older age groups. Life-time prevalence of tranquilizer/sedative use was lower among older age groups.
Conclusions: The high prevalence of using alcohol, crack, and inhalants is a major issue because they are used extensively among different age groups, including minors. Such findings are beneficial for policy-makers, health authorities, and professionals in developing programs aimed at minimizing inhalant use and other types of substance use harms among this group. It is important to accurately monitor this risk-exposed population to understand the mechanisms that might help protect them from high-risk substance use.

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Introduction

Millions of children live on streets worldwide (1), encountering discrimination, inequities, and major discomfort. According to the United Nations Children's Fund (UNICEF), children living and working on the street are categorized into three classes, namely: 'children of the street', 'children on the street' and 'children from street families' (2). While the second category of this population have constant familial connections and live at home during nighttime, they spend a substantial amount of their time on working on the street to financially assist their families. However, children of the street lack familial ties and work and sleep on the streets. Lastly, children from the street live on the street with their families (2).

Street-involved children and youth (SICY) are found across the world. However, various underlying factors, depending on income level of different regions, lead to this consequence (3). For example, young people from high-income countries are driven to live on streets by family-related issues and experience of abuse (4). Other precipitating factors that force children to live on the street include familial dysfunction, parental death, poverty, abject neglect, child abuse, socio-cultural, religious beliefs, and war (5, 6). Such conditions expose SICY to great risks for exchanging sex for money and/or substances (7, 8). Being involved in the 'street economy' such as the sex trade, or selling or panhandling drugs may expose SICY to psychological and behavioral risks which may cause serious consequences such as substance use, sexually-transmitted infections (STIs), violence, and physical and sexual abuse (9).

Encountering multiple acute and frequent health conditions is common among SICY. For instance, SICY are at high risks for developing respiratory issues, such as tuberculosis (10), HIV-infection (11), and other sexually-transmitted diseases (12). Additionally, the risks of suicide attempts, as well as experiencing conduct disorder, bipolar disorder, depression, and post-traumatic stress disorder are more substantial among SICY (13). Such mental health difficulties are exacerbated with past experiences of sexual abuse and could pave the way for lacking constant accommodation (14). Notably, SICY in developed countries present different patterns of psychoactive substance use (15). The type of abused substances differs between SICY in low- and high-income countries. For instance, injection drug use is more common among SICY in developed regions (16, 17). Living on/of the street is associated with numerous biopsychosocial harms among SICY (18). Therefore, health authorities and experts need to understand the particular health necessities among at-risk SICY individuals and monitor them to facilitate their access to community-level support services.

As far as the present authors are aware, the exiting literature mainly reports the prevalence and type of substances with respect to psychoactive substance use patterns among SICY. The reported prevalence estimates are inconsistent and often very diverse within countries and geographical regions. Only one previous meta-analysis has been conducted among street children in resource-constrained settings (15). In addition to being ten years old, the previous meta-analysis only reported (i) substance use among SICY in resource-constrained settings (not all countries all over the world), (ii) lifetime estimates of some specific substances such as alcohol, inhalants, and tobacco (and no other drugs such as crack, solvents, and tranquillizers/sedatives, opioids or polysubstance use), and (iii) did not report the pooled prevalence of psychoactive substance use per country (they reported pooled prevalence of substance use per continent). Moreover, the previous meta-analysis did not run any subgroup analysis by age and time of publication.

Also, there are no reported pooled data on prevalence and types of alcohol and drugs used by categories such as geographical region, or the characteristics associated with SICY's alcohol and drug use and their reasons for use. In addition, no previous meta-analyses concerning the prevalence of substance use in terms of age and year of study publication have been conducted. Epidemiological information focusing on alcohol and drug use among SICY as well as its associated factors is required to improve the knowledge regarding the problem. Such data would contribute to programs designed for reintegrating children into communities. Therefore, the present systematic review and meta-analysis aimed to determine the prevalence, distribution, sociodemographic determinants and risk-taking associated with alcohol and drug use among SICY.

Methods

Search strategy

English-language papers and abstracts published in *Scopus, PubMed, Web of Science,* and *Cochrane* library databases were systematically searched from December 1 1985 to July 1 2022. Also, to identify any other possible relevant studies, *Google Scholar* was also searched. The search strategy was as follows: ('street children' OR 'street youth' OR 'homeless youth' OR 'homeless children' OR 'runaway children' OR 'runaway youth') AND ('substance use' OR 'substance misuse' OR 'substance abuse' OR 'drug use' OR 'drug misuse' OR 'drug abuse' OR 'alcohol use' OR 'inhalant use' OR 'crack use' OR 'solvent use' OR 'opioid use' OR 'polysubstance use'). The reference lists of the included studies were also reviewed to identify any other relevant studies. If a study was conducted with a same sample of SICY, the one that reported more details on the prevalence of drug use was selected. **Supplementary File 1 (SF1)** demonstrates more details of the search strategy, including the keywords used for each database.

Study eligibility criteria and PECOs (participants, exposures, comparison, outcome, and study design) criteria

The present systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (19, 20). The PECOs criteria were used for: (a) participants: 'street-involved children and youth' were considered as any child (aged 0–18 years) or youth (aged 15–24 years) who spend a proportion or majority of their life on the streets. Some studies defined them as 'children on the street', 'children of the street', street children, working children, parking boys, or market children; (b) exposures: sociodemographic determinants and risk-taking associated with alcohol, and drug use; (c) comparison: other street-involved children and youth; and (d) outcomes: life-time alcohol and drug use including ever using a psychoactive substance (at least once) and current drug use (defined as having used a psychoactive substance within the past 30 days). Alcohol and drug use often begins in childhood and adolescence, and most studies to date have assessed life-time and current (past 30 days) alcohol

and drug use (15, 21-24). The reported overall prevalence without specifying the time period was considered as lifetime use for meta-analysis purposes.

Inclusion and exclusion criteria

The present study had the following inclusion criteria: (i) studies including prevalence data considering SICY's alcohol, tobacco, and drug use. The reported prevalence in the studies must have reported at least one of the following: life-time and/or current alcohol, crack, inhalants, solvents, tranquillizers/sedatives, opioids and polysubstance use; (ii) participants being aged up to 24 years (including children and youth) according to the definition of SICY in the present study; and (iii) studies being published in the English language. The following study types were included: cross-sectional, cohort, case-control, mixed-methods, and interventions with baseline data. The studies that did not report prevalence data were excluded. Other exclusions included (i) studies which had high heterogeneity or outcome variations from the considered groups, (ii) unpublished theses (e.g., PhDs, Master's dissertations), and (iii) systematic reviews or meta-analyses, and (iv) qualitative studies.

Study selection process and data extraction

EndNote X7 software was used to remove the duplications. First, two authors (BA/RM) reviewed the titles and abstracts separately considering the study inclusion and exclusion criteria. Any disagreements were resolved by asking help of a third author (EA). In the second step, the full texts of studies were reviewed according to the eligibility study criteria. Data were extracted by two authors (BA/RM) independently according to: author, year of publication, country, study design, sample size, population details, associated sociodemographic determinants and risk-taking, and alcohol and drug use assessment. In cases where necessary, authors of the selected studies were contacted for further details. Disagreements between two authors (<10% in total) were resolved by a third author.

Study quality assessment

The Newcastle-Ottawa Scale (NOS) (25-27) was used for quality assessment of studies, comprising three criteria: (i) the selection domain, including the representativeness of the exposed group, non-exposed group selection, and ascertainment of exposure (three items in cross-sectional studies and four items for cohort studies); (ii) the comparability domain, such as group comparability regarding the study design or analysis (one item each for both cross-sectional studies and cohort studies), and (iii) the exposure/outcome domain, including outcome assessment (one item for of cross-sectional studies and three items for cohort studies). Studies were categorized as unsatisfactory, satisfactory, good or very good. The maximum score was 8 for cohort and case control studies. A total score of 0-2 were considered "unsatisfactory," 3-4 "satisfactory," 5-6 "good" and 7-8 "very good" respectively. The agreement levels of poor, slight, fair, moderate, substantial, and almost perfect were considered by the values 0, 01–0.02, 0.021–0.04, 0.041–0.06, 0.061–0.08, and 0.081–1.00, respectively (28). In total, 26 studies were rated as high quality, 41 studies were rated as good quality, and 13 studies were rated as satisfactory quality **(SF2).**

Ethics approval and consent to participate

The present study was an analysis of preexisting literature and did not use human participants.

Data synthesis and statistical analysis

The present meta-analysis aimed to estimate the pooled-prevalence of lifetime and current alcohol and drug use by geographical region as well as psychoactive substances and injecting drug use by age and year of publication. Lifetime or current drug use prevalence for alcohol and drug use including alcohol, crack, inhalants, solvents, tranquillizers/sedatives, opioids and polysubstance use were considered. Robust random-effects model (i.e. the DerSimonian–Laird

method) was applied to determine the pooled prevalence rates (29). Unlike with the more restrictive fixed-effect model such as Mantel–Haenszel method (30), this model considers samples from heterogeneous populations. It also allows the prevalence estimates to vary not only because of the random error within studies (as in the fixed-effects model), but also because of true variation from one study to another. I^2 statistics were applied for heterogeneity assessment between studies, which evaluate the percentage of variation among studies (31). Considering to the I^2 index, a random effect model was selected to estimate the pooled effect size in defined subgroups (32). Subgroup analyses were performed by age and year of publication of studies to assess the possible source of heterogeneity or reduce it. Egger's approach was performed to assess publication bias, both graphically and statistically (33, 34). A *p*-value of 0.05 was considered significant. To assess the undue influence on the meta-analysis in each of the geographical categories a sensitivity analysis was used on the geographical data. To illustrate the different prevalence on the world map, the latitude and longitude values of the world map were extracted by geocoding using the *geopandas Python* package and the visualizations were performed using *folium library* in *python* language on the *Google Collaboratory* research platform. The association between street-involved children and youth's psychoactive substance use in resource constrained settings and sociodemographic determinants and risk-taking were assessed by odds ratios (ORs), and 95% CIs. The results were demonstrated using forest plots. For data analysis, *R 3.5.1* with the *meta* package was used for the meta-analysis.

Results

Study characteristics

Of the 16,155 papers found, 5,073 were duplicates; 11,082 were screened by title and abstracts; 156 were selected for full text review, and 73 were finally retained in this systematic

review (16, 23, 24, 35-104). Main reasons for exclusion for the title and abstract search and full text review are presented in detail in **SF3**. Of the 73 studies, 28 were based on data collected from the America Region (n=18,333 participants) and 25 from the Africa Region (n=6,565 participants). Canada was the country with the highest number of included studies (18 studies and 3669 participants). Based on countries where the data were collected and considering the World Bank country income level, there were 21 studies from higher-income countries (n=10,910), six studies from upper middle-income countries (n=9,323), 40 studies from lower middle-income countries (n=13,755), and six studies from lower-income countries (n=1,612). Study sample sizes ranged from 30 to 5,268 SICY, with 55 studies including both males and females, seven males only, and 11 studies not reporting the gender of their populations. Most studies (62 of 73) were cross-sectional. Approximately half of studies (49%) used the UNICEF definition of street children in their inclusion criteria. Only 15 studies considered both children and youth of and on the street, 16 studies considered only children and youth of the street, 19 studies considered only children and youth on the street, and 23 studies did not report their samples in terms of children and youth of and on the street **(Table 1)**.

Geographical distribution of life-time and current prevalence of alcohol and drug use among SICY

The prevalence rates of alcohol use varied substantially worldwide, from 11.5% in Ethiopia to 88.23% in the US (lifetime), and from 11.7% in India to 72.2% in Russia (current). The prevalence rate of crack use was from 13.31% in Brazil to 49.96% in the US (lifetime) **(SF4-SF5)**. The prevalence rates of inhalant use were from 18.24% in Cameroon to 78% in the US (lifetime), and from 4% in the US to 40.1% in Russia (current) **(SF6-SF7)**. The prevalence rate of solvents use was from 29.9% in Canada to 67.1% in Nepal (lifetime) **(SF8)**. The prevalence rates of

tranquillizer/sedative use were from 0.5% in India to 35.66% in Canada (lifetime) **(SF9)**, and from 1.2% in Brazil to 24.25% in Canada (current) **(SF10)**. The prevalence rate of opioid use was from 7.5% in Egypt to 75% in Canada (lifetime) **(SF11)**. The prevalence rate of polysubstance use was from 55.05% in India to 96% in the US (lifetime) **(SF12)** (**Table 2**).

Pooled prevalence of life-time and current alcohol and drug use among SICY

The pooled lifetime prevalence rates were 44% for alcohol (95% CI, 37-51%), 44% for crack (95% CI, 34-54%), 33% for inhalants (95% CI, 24-42%), 44% for solvents (95% CI, 26-63%), 16% for tranquillizer/sedatives (95% CI, 0.8-25%), 22% for opioids (95% CI, 9-34%), and 62% for polysubstance use (95% CI, 45-79%) **(Figures 1-7)**. The pooled current prevalence rates were 40% for alcohol (95% CI, 27-52%), 21% for crack (95% CI, 10-32%), 20% for inhalants (95% CI, 4-36%), 11% for tranquillizer/sedative use (95% CI, 0-23%), and 1% for opioid use (95% CI, 0-3%) **(SF13-SF17)**.

Subgroup analyses of pooled prevalence of life-time and current alcohol and drug use by age of participants among SICY

Subgroup analysis was performed based on age of participants and the participants were categorized into three groups: (i) 10-14 years, (ii) 15-18 years, and (iii) 18 to 24 years. The results confirmed that life-time and current prevalence of alcohol, crack use, current prevalence of tranquillizer/sedatives, and life-time prevalence of polysubstance use was higher among older age groups while life-time prevalence of tranquillizer/sedatives was lower among older age groups **(Table 3, SF18-SF24)**.

Subgroup analyses of pooled prevalence of life-time and current alcohol and drug use by time of publication of studies among SICY

Given that reported prevalence estimates in this area are inconsistent and vary over time (22, 105), a subgroup analysis was performed based on time of publication of studies and categorized the studies into three time periods: (i) before 2000, (ii) 2000-2011 and (iii) 2012–2022. Analysis indicated that (i) life-time prevalence of alcohol use and inhalant use decreased over time, (ii) life-time and current prevalence of tranquillizers/sedative use and opioid use decreased over time, (iii) current prevalence of alcohol use did not have any discernable pattern over time, and (iv) life-time prevalence of crack use and solvent use increased over time **(Table 4 and SF25-SF32).**

Subgroup analyses of pooled prevalence of life-time and current alcohol and drug use by quality of studies during time of publication among SICY

Also, another subgroup analysis was conducted based on the quality of studies during time of publication and the studies were categorized into three types of quality during the time periods: (i) satisfactory quality, (ii) good quality and (iii) high quality. It was found that over time, the higher the quality of papers, the (i) lower the life-time prevalence of alcohol and inhalant use, and (ii) the higher the lifetime prevalence of crack use (**SF33-SF39**).

Sociodemographic determinants and risk-taking associated with life-time or current alcohol and drug use among SICY

The study found that SICY who were >14 years were 1.60 times more likely than those aged 14 years or younger to have life-time or current substance use (OR=1.60, 95% CI=1.34-1.92). Those who were female were 2.64 times more likely than males to have life-time or current substance use (OR=2.64, 95% CI=1.68-4.15). SICY who were engaged in child labor, were rag pickers or a waitress in hotel were 4.77 times more likely than those who were not to have life-

time or current substance use (OR=4.77, 95% CI=2.27-10.02). Those who lived on the street > one year were 2.81 time more likely than those who had lived on the street <1 year to have life-time or current substance use (OR=2.81, 95% CI=1.99-3.97). Those who experienced non-fatal overdose were 1.70 times more likely than those who did not experience non-fatal overdose to have life-time or current substance use (OR=1.70, 95% CI=1.20-2.42). Finally, participants who experienced sexual abuse in their life-time were 2.93 times more likely than those who did not had not experienced sexual abuse in their life-time to have life-time or current substance use (OR=2.93, 95% CI=1.38-6.22) **(SF40, SF41).**

Publication bias of studies

To identify probable publication bias, the Egger's test was performed. The publication bias test indicated considerable bias based on Egger's test (coefficient=3.66, p<.001). Therefore, met-trim analysis was performed in order to remove the effect of publication bias on the pooled OR. The meta-trim analysis indicated that the pooled OR was 0.19 (95% CI, 0.13–0.24) in the random effect model. Although publication bias was observed across studies, meta-trim analysis indicated that results from unpublished studies would not change the pooled prevalence rate of alcohol/drug use among SICY.

Discussion

The present systematic review and meta-analysis found a high prevalence of psychoactive substance use among SICY with significant variation by geographical region and study methodology. No pooled prevalence for majority of these substances has previously been reported in relation to SICY. Pooled prevalence of alcohol use was higher than the percentages reported in

a previous meta-analysis (44% vs. 41%) (15) but pooled prevalence of inhalant use was lower than the percentages reported in a previous meta-analysis (33% vs. 47%) (15).

According to a large body of literature, familial connections, the place where SICY stay at night, and the duration of involvement with living on street impact substance use in this population. In the present study, being female, being of older age (>14 years), involvement in child labor or rag picking, as well as had history of sexual abuse were associated with alcohol and drug use among this population. As aforementioned, duration of the experience of living on street was significantly related with substance use. In the present study, the odds of substance use were 2.81 times higher among those who lived on street for > one year, relative to their counterparts who had less than one year of living on the street. This concurs with findings obtained in previous studies in Brazil (104) and Iran (52). Furthermore, in another study in Ethiopia, the odds of substance use were five times higher in children and youth who reported >5 years of living on street, compared to their peers with ≤1 year of the same condition (41). The higher substance use among the former group may be explained by using substances as a way of coping with the complications of living on street. Substance use is one of the methods to avoid stress encountered due to living on the street and reduce various traumatic and adverse events (106). This finding was also supported by another study (107). Additionally, this vulnerable population may drink alcohol and use other illicit drugs to alleviate their stress caused by outdoor living and hunger (108). Youth living on streets may attempt using some types of substances (e.g., stimulants) to keep alert, particularly during nighttime when the odds of being exposed to violence is higher (108, 109).

The findings of present study highlighted that the individuals aged >14 years reported two times higher substance use compared to the age group below 14 years. This result was in line with studies conducted in Ethiopia (41) and Brazil (104). Overall, the odds of involvement with

substance use is higher among older children (41). Evidence indicates that among the ninth grades 20-30% of adolescents have used alcohol or other drugs, and that this increases among twelfth graders to 50-70% (110). Some substance use among adolescents older than 14 years may be viewed as acceptable or the norm. However, those older than 14 years who engage in substance use occasionally have been reported to demonstrate more externalizing behaviors and have poorer mental health and academic outcomes their drug-abstaining peers (111).

Previous studies have indicated that the rate of substance use was higher among homeless male adolescents, relative to their female counterparts (60, 112). However, another study reported higher rates of substance use among homeless female adolescents, relative to their male counterparts. The authors attributed this finding to higher histories of sexual abuse among females (113). Additionally, substance use might be a mechanism to cope with the challenges associated with living on street (114). Some scholars extended this argument and suggested SICY not only use substances as a manner of coping but to also become accepted in their peer group and blend into the street culture (114). The finding that the prevalence rate of substance use was higher among females may be due to several reasons. First, there were only two studies which reported drug use among female individuals. Second, alcohol-generated health conditions occur among females at lower consumption rates, relative to males (115, 116). Females are also more likely to experience a more severe progression from alcohol use to addiction, which is known as "telescoping" (116). Finally, males who stop using alcohol after adolescence are similar to males who did not have any history of alcohol use regarding antisocial behavior and mental health problems. However, females who stop using alcohol use after adolescence are dissimilar to females who did not have alcohol use history (117). As a result, not only should higher vulnerabilities to

using alcohol and drugs be considered in adolescents, but also it is essential to address their needs concerning future functioning in relation to gender.

Consistent with some prior obtained data, the present study found a strong association between rag picking and injection drug use in this population (63). For instance, rag pickers in Bolivia reported higher exposure to individuals with substance use disorders and drug suppliers, relative to non-rag picker SICYs (61). Another study in Canada (118) addressed headaches and other physical conditions associated with working in hot weather (which is common among SICY who practice long-time rag picking as the main source of income in hot weather).

The present study's findings indicated that SICY who experienced sexual abuse were more likely to use alcohol and other drugs. Based on the results of a cross-sectional study, a history of sexual abuse was significantly associated with engaging in drug injection among adults (119). Previous research has suggested that economically disadvantaged groups such as SICY who are also socially isolated, may experience sexual abuse and victimization (109). There are several possible explanations. First, such childhood traumatic events result in long-term negative influences on individuals. Potentially, some SICY may seek use of alcohol and other drugs as a way to 'numb' themselves or self-medicate in response to encountering sexual abuse before living on the street (120). Second, studies have indicated that inappropriate sexual behavior (121), low self-esteem (122), promiscuity, internalizing and externalizing issues (123), depression and posttraumatic stress disorder (124), anger (125), are short-term outcomes of sexual abuse experiences. Lastly, adulthood self-destructive (126) and/or antisocial behavior (127) may be manifestations of these traumatic childhood experiences.

Gaps in the literature and research priorities

The present study results highlighted that a great proportion of the existing studies investigating substance use among SICY are of descriptive and cross-sectional designs, targeting the prevalence and type of used substances with restricted statistical analysis. Therefore, it is essential to expand research methodologies by performing longitudinal studies to determine the underlying mechanisms of drug use in this group. There is a huge gap of knowledge concerning the risk and protective factors of the onset, duration, and treatment of substance use among SICY. Another limitation of the reviewed literature was that nine studies did not include any females in their samples. Street-involved girls and young women might be both more marginalized and more vulnerable than males and be less accessible for research. This lack of equity is likely to result in an important gender-based selection bias in this field.

Furthermore, there is an important literature gap concerning the biopsychological consequences of multiple-type substance use among SICY. Investigations in other SICY populations reported a significant association between using inhalants and sudden sniffing death syndrome due to cardiac arrhythmia, neuro-cognitive impairments, as well as renal, pulmonary, and teratogenic malfunctions (97, 128, 129). Moreover, volatile solvent use can lead to biopsychological dependence (71). However, data on inhalant dependence and its cognitive and mental consequence among SICY remain limited. In addition, commercial sex work, forced sex, and exchanging sex for drugs is commonly experienced by individuals with substance abuse. While such risks can further lead to exposure to sexually-transmitted infections, including HIV and assaults, data on such links in this vulnerable group remain scarce. (130). Considering the aforementioned information, it is essential to determine the factors associated with drug and alcohol consumption as well as high-risk sexual behavior and sexual violence among this population. The dearth of relevant information points to multiple crucial literature gaps.

Methodological consideration related to results

The studies included in the present systematic review and meta-analysis have some methodological concerns. First, 85% of the included studies were of a cross-sectional design, preventing the delineation of a causal/temporal association between the research variables under study. Second, several of the reviewed studies categorized children attending school as street involved and some studies (nine studies) did not use the UNICEF definition of SICY. Such definitional discrepancies in classifying SICY may complicate data comparison. Therefore, it is crucial to establish a standardized global definition for this population. Third, there was a lack of consistency in defining substance use among various studies. For example, some studies failed to specify the duration (lifetime vs. current), extent, and frequency of substance use. Fourth, another issue that prevented including some studies in the meta-analysis was improperly merging data of various substances. To ensure valid interpretation of the reported data, it is essential to precisely clarify the type, frequency, intensity, and duration of drug use. Fifth, some studies (12 of 73) incorrectly applied the tool developed by the World Health Organization in 1981 for assessing drug use in non-student youth rather than a toll for specifically assessing drug use among SICY (131). Consequently, it is important to develop a comprehensive measure for substance use patterns among SICY to ensure the production of valid and reliable data, in this regard. Sixth, other variables included in the studies were also not retained in the meta-analysis because only one study had examined the variable (i.e., educational status, HIV-infection, being unable to access services, having mental health disorders).

Seventh, some studies related to heroin, cocaine, marijuana, cannabis, and other drugs but due to the low number of studies they were not included in the meta-analysis. Eighth, it is important to note that prevalence estimates might be negatively influenced by social desirability biases. It is

also important to consider the SICY-interviewer connections and sampling origin, as probing substance use-related information can be sensitive. Some under-reporting might occur among SICY in drop-in-centers, and different institutions. Participants may also under-report their substance use if the interviewer fails to build a proper rapport with them. Finally, high heterogeneity was observed between studies. The present study performed several subgroup analyses based on participants' age, time of publication of studies and quality of studies but this did not reduce the heterogeneity. Therefore, other variables that were not assessed in the present study (such as participants' gender) may be sources of the heterogeneity.

Conclusions

Significant public health concerns that require prompt action were identified in the present review study. In particular, the high prevalence of using alcohol, crack and inhalants is major issue because it is extensively available to different age groups, including minors. The adverse consequences of using inhalants requires urgent interventions by authorities and policymakers. Notably, inhalant use may socially isolate SICY and further decrease their quality of life. Their health can be endangered by using substances by being exposed to great risks for HIV-infection and mortality. However, further research is required to determine the underlying factors associated with substance use and health outcomes among SICY. Such data could be beneficial for policymakers and health authorities and professionals to develop programs aimed at minimizing inhalant use and other types of substance use harms in this group. Therefore, it is of great importance to accurately monitor this risk-exposed population to understand the mechanisms that might help protecting them from high-risk sexual behavior and substance use.

It is optimal for various organizations public and private sectors to collaborate for minimizing the number of SICY. Such measures could comprehensively address the needs and complicated life conditions of this group at three level of interventions. Initially, the interventions of this population should be targeted at individual-level and classifying them based on substance use patterns, such as current use, exposure to the risk of substance use, as well as the potential sexual risks. They could then receive relevant training on developing helpful skills, and/or medical and psychological interventions. At the next level, professionals can intervene at community and family levels. Some related programs could include community support plans, service provision, and extending access to these services. Finally, some interventions can target beyond the workplaces and communities of SICY. Advocacy programs that incorporate education as well as regional and national support can be considered at this third-level to improve the conditions of SICY.

Abbreviations

CIs: Confidence intervals

NOS: Newcastle-Ottawa Scale

OR: Odds ratio

PECOs: Participants, exposures, comparison, outcome and study design

PRISMA: Protocols of systematic reviews and meta-analyses

SICY: Street-involved children and youth

UNICEF: United Nations Children's Fund

WHO: World Health Organization

Disclosure statement

The authors declare that there are no conflicts of interest.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

Author contributions

BA – Conceived the study BA – collected all data. BA and RM – analyzed and interpreted the data. BA and EA – drafted the manuscript. MDG and BA contributed to the revised paper and were responsible for all final editing. All authors commented on the drafts of the manuscript and approved the final copy of the paper for submission.

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Table 1. Characteristics of the 73 studies identified for review.

First author [reference no]	Year of publication	n	Country	Design	Mean/range of age (years)	Male N (%)	Female N (%)	OF the street	ON the street
Bhattacharjee et al. (45)	2016	159	India	Cross- section	14.3	NR	NR	0 (0)	159 (100)[a]
Hadland et al. (59)	2010	560	Canada	Cohort	14–26	381 (68)	179 (32)	0 (0)	560 (100)[a]
Tiwari (98)	2007	402	India	Cross- section	6–16	402 (100)	0 (0)	0 (0)	402 (100)[ac]
Chami et al. (48)	2013	422	Canada	Cohort	14–26	289 (68)	133 (32)	0 (0)	422 (100)[a]
Fairbairn et al. (55)	2017	1149	Canada	Cohort	14–26	790 (69)	359 (31)	NR	NR
Islam et al. (62)	2014	215	Nigeria	Cross- section	5–18	195 (91)	20 (9)	NR	NR
Gupta et al. (58)	2013	502	India	Cross- section	5–19	390 (76)	122 (24)	NR	NR
Ataei et al. (38)	2010	399	Iran	Cross- section	12.74	271 (68)	128 (32)	NR	NR
Ayenew et al (41)	2020	312	Ethiopia	Cross- section	12–24	281 (90)	31 (10)	312 (100)[a]	0 (0)
Hadland et al. (60)	2011	559	Canada	Cohort	14–26	389 (68)	179 (32)	0 (0)	559 (100)[a]
Robbins et al. (91)	2010	929	Ukraine	Cross- section	18–24	706 (76)	233 (24)	NR	NR
Auerswald et al. (39)	2013	300	Kenya	Cross- section	13–21	299 (99)	1 (1)	300 (100)c	0 (0)
Whitworth et al. (102)	1997	1244	Honduras	Cross- section	13	722 (58)	522 (42)	160 (13)[ab]	1084 (87)
Okasha and Abou-Hatab (80)	2010	100	Egypt	Cross- section	NR	NR	NR	NR	NR
Kissin et al. (70)	2007	313	Russia	Cross- section	15–19	198 (63)	115 (37)	NR	NR
Oppong Asante et al. (83)	2014	227	Ghana	Cross- section	12.58	122 (54)	105 (46)	0 (0)	227 (100)[a]
Bal et al. (42)	2010	554	India	Cross- section	11–15	362 (65)	192 (35)	NR	NR
Othieno et al. (84)	2000	50	Kenya	Cross- section	10–19	36 (72)	14 (28)	NR	NR
Tyler et al. (99)	2016	250	Zambia	Cross- section	14–24	179 (71)	71 (29)	0 (0)	250 (100)[a]
Brands et al. (46)	2005	49	Canada	Cross- section	12–19	25 (51)	24 (49)	NR	NR
Embleton et al. (54)	2012	146	Kenya	Cross- section	10–19	114 (78)	32 (22)	98 (67)[ab]	48 (33)
Kayembe et al. (65)	2008	880	Congo	Cross- section	17.5	692 (79)	188 (21)	880 (100)	0 (0)
Kirst et al. (68)	2011	150	Canada	Cross- section	16–21	75 (50)	75 (50)	0 (0)	150 (100)[c]
Kudrati et al. (71)	2007	432	Sudan	Cross- section	11–18	397 (92)	35 (8)	330 (76)[c]	102 (24)
Praneeth Reddy et al. (90)	2014	603	India	Cross- section	11–14	603 (100)	0 (0)	NR	NR
Campos et al. (47)	1994	376	Brazil	Cross- section	9–18	289 (77)	87 (23)	200 (53)[b]	176 (47)
Pagare et al. (85)	2004	115	India	Cross- section	6–16	115 (100)	0 (0)	NR	NR
Dejman et al. (52)	2015	259	Iran	Cross- section	15–18	192 (74)	67 (26)	259 (100)[a]	0 (0)
Kipke et al. (67)	1996	106	USA	Cross- section	16–24	57 (54)	49 (46)	77 (73)[bc]	29 (27)
Kautilya et al. (64)	2015	30	India	Cross- section	NR	30 (100)	0 (0)	NR	NR
Embleton et al. (53)	2013	146	Kenya	Cross- section	10–19	114 (78)	32 (22)	98 (67)[ab]	48 (33)
Salem and Abd el-Latif (95)	2002	100	Egypt	Cross- section	7–16	100 (100)	0 (0)	94 (94)[a]	6 (6)
Bah (103)	2021	117	Gambia	Cross- section	7–17	NR	NR	0 (0)	117 (100)[a]
Asante and Nefale (37)	2021	326	Ghana	Cross- section	8–19	250 (61)	126 (39)	0 (0)	326 (100)[c]
Mambwe et al. (73)	1997	100	Zambia	Cross- section	9–18	70 (70)	30 (30)	NR	N
Moura et al. (104)	2012	2807	Brazil	Cross- section	10–18	2120 (75)	687 (25)	0 (0)	2807 (100)[b]
Adlaf et al. (36)	1996	217	Canada	Cross- section	NR	160 (74)	57 (26)	NR	NR
Okwaraji et al. (81)	1996	100	Nigeria	Cross- section	13	60 (60)	40 (40)	NR	NR
Roy et al. (93)	2003	415	Canada	Cross- section	19.5	284 (69)	131 (31)	0 (0)	415 (100)[a]
Praveen et al. (88)	2012	174	India	Cross- section	5–18	106 (61)	68 (39)	NR	NR
Kakchapati et al. (63)	2018	350	Nepal	Cross- section	NR	288 (82)	62 (18)	350[a]	0 (0)
Njord et al. (78)	2010	311	Philippines	Cross- section	13–17	182 (59)	129 (41)	141 (45)[ab]	171 (55)
Roshanfekr et al. (24)	2020	856	Iran	Cross- section	13.8	729 (91)	81 (9)	856 (100)[a]	0 (0)
Werb et al. (101)	2013	395	Canada	Cohort	14–26	NR	NR	395 (100)[a]	0 (0)
Salaam (94)	2011	173	Nigeria	Cross- section	19.3	NR	NR	NR	NR
Cumber and Tsoka-Gwegweni (50)	2016	399	Cameroon	Cross- section	12–17	320 (80)	79 (20)	399 (100)[a]	0 (0)
Ayaya and Esamai (40)	2001	141	Kenya	Cross- section	5–21	NR	NR	47 (33)[a]	38 (27)
Baron (43)	1999	200	Canada	Cross- section	18.86	NR	NR	200 (100)[a]	0 (0)
Mabouopda et al. (72)	2022	159	Cameroon	Cross- section	16.1	159 (100)	0 (0)	159 (100)[a]	0 (0)
Huang et al. (61)	2004	159	Bolivia	Cross- section	3–18	85 (68)	39 (32)	124 (78)	35 (22)
Meshram et al. (75)	2015	305	India	Cross- section	8–18	NR	NR	305 (100)[a]	0 (0)
Torres de Carvalho et al. (51)	2006	161	Brazil	Cross- section	10–18	128 (80)	33 (20)	NR	NR
Shanthi and Eljo (96)	2022	23	India	Cross- section	13.87	NR	NR	23 (100)[a]	0 (0)
Gleghorn et al. (57)	1998	1121	USA	Cross- section	>18	717 (64)	404 (36)	0 (0)	1121 (100)[a]
Roy et al. (92)	2011	946	Canada	Cohort	19.35	574 (60)	243 (40)	0 (0)	946 (100)[a]
Clements et al. (49)	1997	429	USA	Cross- section	19.2	292 (68)	137 (32)	429 (100)[a]	0 (0)
Morakinyo and Odejide (76)	2003	180	Nigeria	Cross- section	18	174 (97)	6 (3)	0 (0)	180 (100)[a]
Obando et al. (79)	2004	5268	Costa Rica	Cross- section	12–20	NR	NR	NR	NR
Dhawan et al. (23)	2020	766	India	Cross- section	NR	NR	NR	766 (100)[a]	0 (0)
Olley (82)	2006	169	Nigeria	Cross- section	11–24	151 (89)	18 (11)	169 (100)[c]	0 (0)
Nada and Suliman (77)	2010	857	Egypt	Cross- section	12–17	727 (85)	130 (15)	857 (100)[a]	0 (0)
Kirst et al. (69)	2009	150	Canada	Cross- section	16–20	75 (50)	75 (50)	131 (87)[ab]	19 (13)
Adebiyi et al. (35)	2008	360	Nigeria	Cross- section	16.2	210 (58)	150 (42)	51 (14)[ac]	309 (86)
Pinto et al. (87)	1994	398	Brazil	Cross- section	10–18	279 (70)	119 (30)	195 (49)[b]	199 (51)
Asante and Nefale (37)	2021	326	Ghana and South Africa	Cross- section	8–19	250 (61)	126 (39)	0 (0)	326 (100)[c]
Phillips et al. (86)	2015	1017	Canada	Cohort	14–26	698 (69)	319 (31)	NR	NR
DeBeck et al. (19)	2013	405	Canada	Cohort	14–26	274 (68)	131 (32)	0 (0)	405 (100)[a]
Sherman et al. (97)	2005	347	Pakistan	Cross- section	13	333 (96)	14 (4)	261 (75)[c]	41 (12)

(*Continued*)

Table 1. (Continued).

First author [reference no]	Year of publication	n	Country	Design	Mean/range of age (years)	Male N (%)	Female N (%)	OF the street	ON the street
Kerr et al. (66)	2009	560	Canada	Cross- section	21.9	381 (68)	179 (32)	NR	NR
Gaidhane et al. (56)	2008	163	India	Cross- section	10–19	100 (100)	0(0)	83 (51)[c]	80 (49)
Basu et al. (44)	2021	150	India	Cross- section	12.82	93 (62)	57 (38)	NR	NR
Uhlmann et al. (100)	2014	1019	Canada	Cohort	14–26	699 (69)	320 (31)	0 (0)	1019 (100)[a]
Reddon et al. (89)	2018	481	Canada	Cohort	14–26	NR	NR	NR	NR
Marshall et al. (74)	2010	560	Canada	Cohort	14–26	106 (65)	56 (35)	0 (0)	162 (100)[a]

[a]Utilized the UNICEF ON/OF classifications for street children's inclusion.
[b]Reported UNICEF ON/OF classifications in results.
[c]Review derived ON/OF classifications based on study results indicating sleeping at "home" or in streets/public places.
NR = Not reported.

Table 2. Pooled prevalence of life-time and current prevalence of alcohol and drug use by geographical region among street-involved children and youth.

Geographic distribution (countries)	Type of psychoactive substances and other drug use	Number of studies	Lifetime pooled prevalence rate %	Number of studies	Current pooled prevalence rate %
Canada	Alcohol	11	51.36	3	29.5
	Crack	10	48	NR	NR
	Inhalant	2	18	1	26
	Solvents	1	29.9	NR	NR
	Tranquilizers/sedatives	3	35.66	2	24.25
	Opioids	1	75	NR	NR
	Polysubstance use	1	55.4	NR	NR
USA	Alcohol	4	88.23	2	64.65
	Crack	3	49.96	NR	NR
	Inhalants	1	78	1	4
	Opioids	1	26	NR	NR
	Polysubstance use	1	96	NR	NR
Costa Rica	Alcohol	1	65	NR	NR
	Crack	1	55	NR	NR
	Inhalants	1	30	NR	NR
	Tranquilizers/sedatives	1	18	NR	NR
Honduras	Alcohol	1	43.1	NR	NR
Brazil	Alcohol	3	64.26	1	40
	Crack	2	13.31	NR	NR
	Inhalants	3	39.13	NR	NR
	Tranquilizers/sedatives	1	4	1	1.2
Bolivia	Alcohol	1	58	NR	NR
Russia	Alcohol	1	27.8	1	72.2
	Inhalants	1	55.2	1	40.1
Ukraine	Alcohol	1	26	NR	NR
Nigeria	Alcohol	6	43.10	2	33.75
	Solvents	2	36.69	NR	NR
	Tranquilizers/sedatives	5	12.68	2	9.15
Kenya	Alcohol	6	40.10	1	16
	Inhalants	1	42	NR	NR
	Solvents	1	37	NR	NR
Democratic Republic of the Congo	Alcohol	1	63.5	NR	NR
Cameroon	Alcohol	2	35.53	NR	NR
	Inhalants	1	18.24	NR	NR
	Tranquilizers/sedatives	1	10.06	NR	NR
	Opioids	1	10.06	NR	NR
Gambia	Alcohol	2	18.82	NR	NR
	Inhalants	2	17.34	NR	NR
	Tranquilizers/sedatives	1	7	NR	NR
	Opioids	2	12.56	NR	NR
Ghana	Alcohol	2	75.8	2	43.65
Zambia	Alcohol	2	68	NR	NR
Ethiopia	Alcohol	2	11.5	2	27.1
	Tranquilizers/sedatives	2	6.6	2	4.2
South Africa	Alcohol	1	79.35	1	73
Egypt	Alcohol	2	11.5	1	35
	Solvents	1	37	NR	NR
	Tranquilizer/sedative	2	30.4	NR	NR
	Opioids	1	7.5	NR	NR
Sudan	Alcohol	1	26	NR	NR

(*Continued*)

Table 2. (Continued).

Geographic distribution (countries)	Type of psychoactive substances and other drug use	Number of studies	Lifetime pooled prevalence rate %	Number of studies	Current pooled prevalence rate %
India	Alcohol	12	24.21	1	11.7
	Inhalant	4	21.5	1	10.9
	Solvents	3	49.33	NR	NR
	Tranquilizers/sedatives	1	0.5	NR	NR
	Opioids	4	20.32	NR	NR
	Polysubstance use	4	55.05	NR	NR
Bangladesh	Inhalants	1	32	NR	NR
Nepal	Alcohol	1	64.3	NR	NR
	Solvents	1	67.1	NR	NR
Philippines	Alcohol	1	73.8	NR	NR
	Inhalants	1	61.7	NR	NR
Iran	Alcohol	3	42.16	NR	NR
	Opioids	1	14.2	NR	NR

NR = not reported.

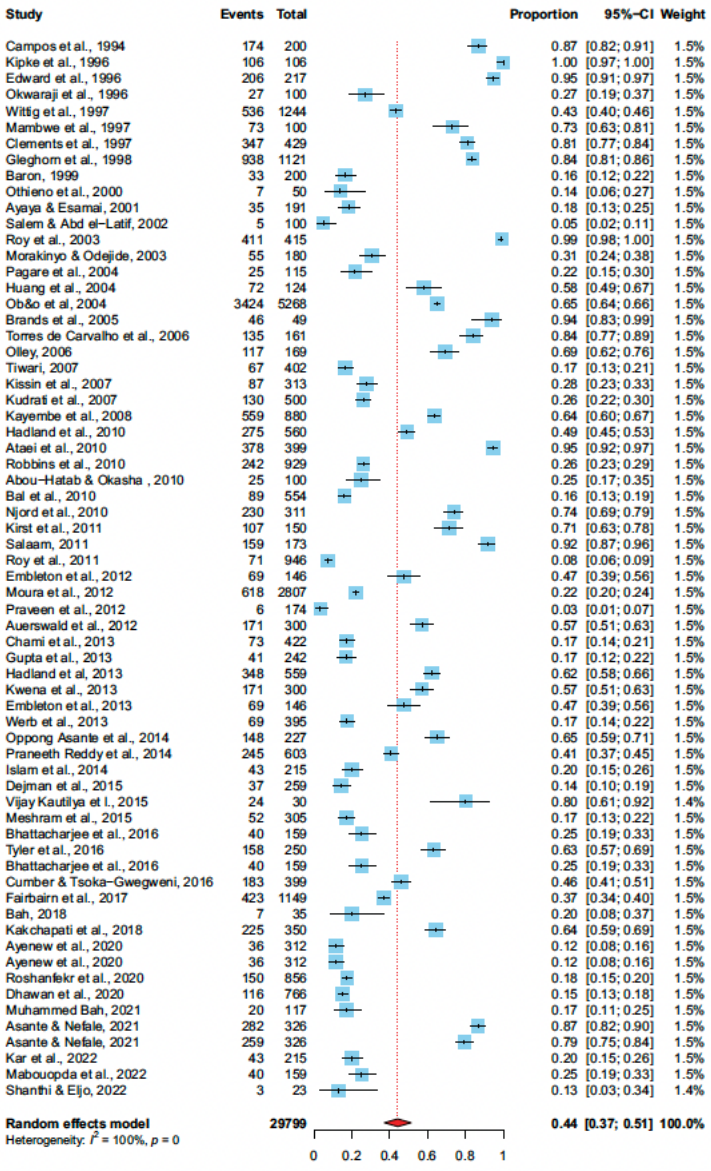

Figure 1. Forest plot and pooled prevalence life-time of alcohol use among street-involved children and youth.

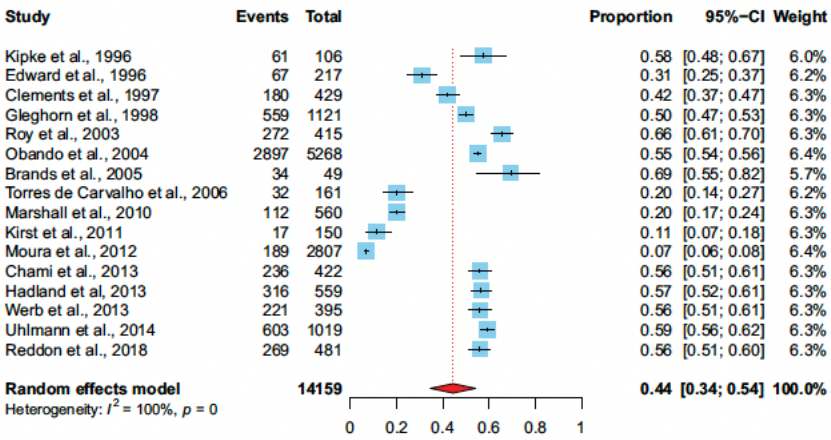

Figure 2. Forest plot and pooled prevalence life-time of crack use among street-involved children and youth.

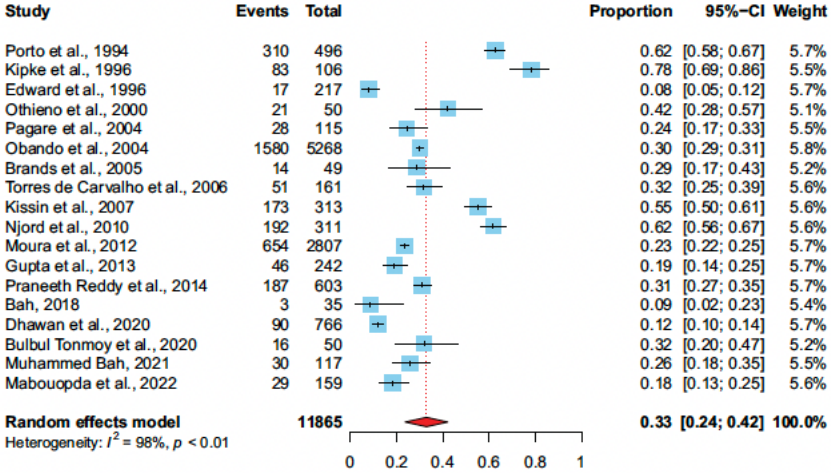

Figure 3. Forest plot and pooled prevalence life-time of inhalants use among street-involved children and youth.

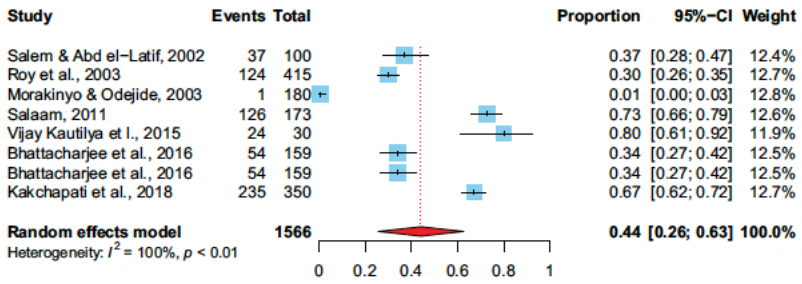

Figure 4. Forest plot and pooled prevalence life-time of solvents use among street-involved children and youth.

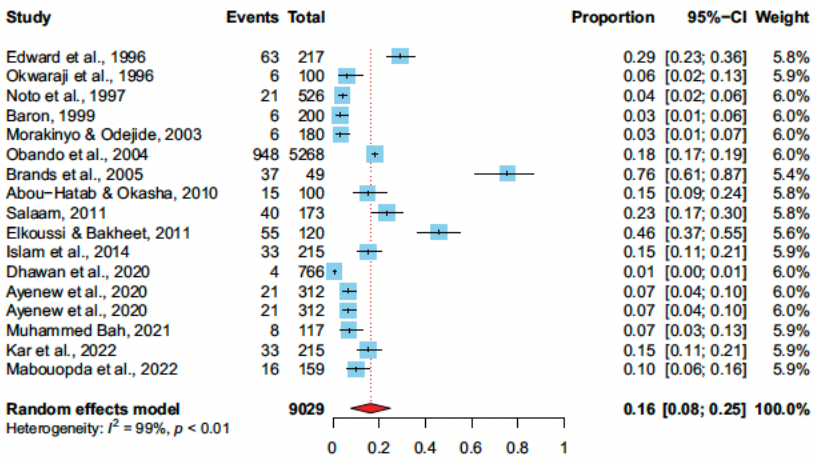

Figure 5. Forest plot and pooled prevalence life-time of tranquillizer/sedatives use among street-involved children and youth.

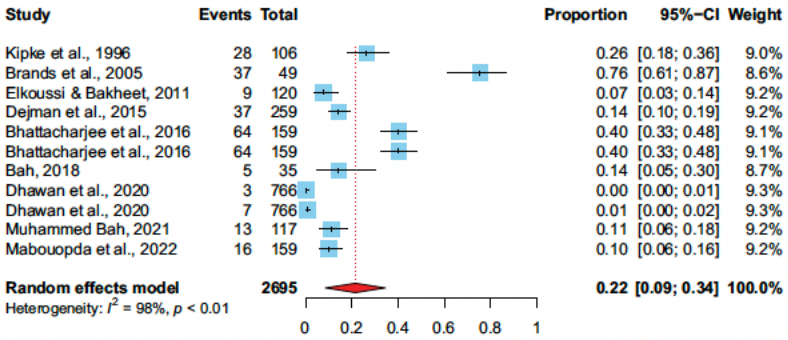

Figure 6. Forest plot and pooled prevalence life-time of opioids use among street-involved children and youth.

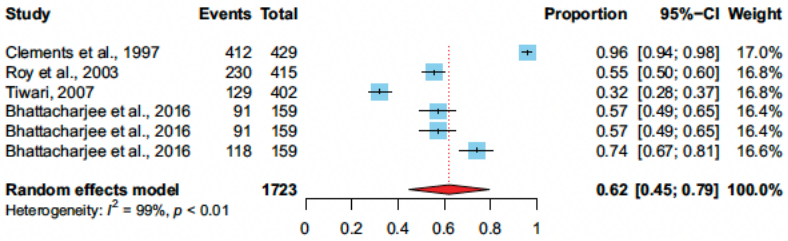

Figure 7. Forest plot and pooled prevalence life-time of polysubstance use among street-involved children and youth.

Table 3. Subgroup analyses of pooled prevalence of life-time and current alcohol and drug use by age of participants among street-involved children and youth.

Pooled prevalence (95% CI)	Type of drug use	10–14 years	15–18 years	18 to 24 years
Lifetime pooled prevalence (95% CI)	Alcohol	37% (0–46%)	46% (0–100%)	56% (0–100%)
	Crack	13% (0–26%)	61% (47–75%)	48% (38–58%)
	Inhalants	24% (0–43%)	9% (10–14%)	13% (0–100%)
	Solvents	NR	NR	NR
	Tranquilizer/sedative	NR	NR	NR
	Opioids	NR	NR	NR
	Polysubstance	55% (0–100%)	NR	76% (36–116%)
Current pooled prevalence (95% CI)	Alcohol	42% (0–100%)	45% (0–100%)	47% (0–100%)
	Crack	NR[b]	11% (0–100%)	17% (9–25%)
	Inhalants	2% (0–5%)	NR	5% (0–11%)
	Solvents	NR	NR	NR
	Tranquilizer/sedative	NR	NR	NR
	Opioids	NR	NR	NR
	Polysubstance use	NR	NR	NR

NR = not reported.

Table 4. Subgroup analyses of pooled prevalence of life-time and current alcohol and drug use by the time of publication of studies among street-involved children and youth.

Pooled prevalence (95% CI)	Type of drug use	Before 2000	2000–2011	2012–2022
Lifetime pooled prevalence (95% CI)	Alcohol	67% (0–100%)	46% (0–100%)	36% (0–44%)
	Crack	45% (0–56%)	35% (0–100%)	57% (25–59%)
	Inhalants	49% (0–100%)	37% (0–47%)	21% (0–27%)
	Solvents	NR[a]	35% (0–100%)	53% (0–100%)
	Tranquilizer/sedative	10% (0–22%)	30% (0–100%)	8% (0–12%)
	Opioids	NR	36% (0–100%)	16% (0–27%)
	Polysubstance	NR	NR	NR
Current pooled prevalence (95% CI)	Alcohol	37% (0–100%)	44% (0–100%)	38% (0–100%)
	Crack	NR	NR	NR
	Inhalants	NR	NR	NR
	Solvents	NR	NR	NR
	Tranquilizers/sedatives	16% (0–100%)	9% (0–20%)	4% (0–6%)
	Opioids	NR	NR	NR
	Polysubstance use	NR	NR	NR

NR = not reported.