context for the development of a young person; children and teenagers are particularly susceptible to peer influence due to the utmost importance of peers at this developmental stage; moreover, the effects of peer influence are stronger during adolescence than in adulthood.[10] Peer interactions may foster healthy or unhealthy development, including substance abuse.[11–13] Some research shows that the tendency to be influenced by peers does not remain constant over time: it is higher during early and middle adolescence than during preadolescence or late adolescence.[14–16] Other authors point out that these age patterns demonstrate gender differences and that this varies depending on the specific behaviour.[17 18]

Adolescents' alcohol consumption is closely associated with the drinking behaviour of their peers.[9] It may thus be concluded that peer influence exerts a role in explaining the willingness to drink alcohol. Furthermore, there is a quantity of research studying different aspects of this process: peer norms, direct and indirect influences, popularity and friendship effects.[19–21] However, the similarity in drinking behaviour patterns may arise from two different processes: the influence of peers on a person's behaviour or the preference of a person to associate with similar others.[22] In order to evaluate peer influence, it is necessary to disentangle it from social homophily, or the tendency to affiliate with people with similar behaviour.[23]

We have been able to identify three systematic reviews of papers analysing the interrelations of adolescents' health risk behaviour and friendship networks. Jeon and Goodson evaluated 15 articles based on the US representative dataset 'Add Health', which study the influence of friendship networks on adolescents' risk behaviour.[24] Jacobs et al, reviewed the role of gender and network sex composition as a determinant of adolescents' risk behaviour.[25] The papers included in their review encompassed a variety of methods: Exponential random graph models (ERGM), Quadratic assignment procedures (QAP), Agent based models (ABM), regression, multivariate and bivariate statistics. A recent study from Leung et al is a systematic review of 22 articles published between 1997 and 2011 which used longitudinal network studies intending to assess the effects of peer influence and selection process on adolescent alcohol use.[26] Only a few reviewed papers used network design and network measures of friendship effects, while the majority were based on perceived measures of alcohol use or deviant behaviour. The described systematic review have used a variety of methods: Ordinary Least Squares Regression (OLS), logistic and hierarchical regressions, latent growth modelling, structural equation modelling, analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA).[24–26] None of these methods, however, are able to separate the effects of peer influence from the confounding effects of peer selection.

The analytic approach that allows separating selection and influence processes is stochastic actor-oriented models (SAOMs). SAOM is a statistical model for the simultaneous, mutually dependent, dynamics of a relation (or social network) of social actors and the behaviour of these actors. A social network may represent any type of social ties, for example, friendship; and behaviour may represent any changing actor's characteristic, for example, alcohol consumption. Actor-oriented models assume that social actors play a crucial role in changing their ties to other actors as well as in changing their behaviour. Thus, the process of co-evolution of networks and behaviour is regarded as a result of the actors' individual decisions and is modelled as a Markov process constructed from the smallest possible steps. SAOMs require longitudinal (panel) network data, that is repeated measures of network ties and actors' attributes. The actor-driven modelling approach can be applied for assessing the strength of both selection and influence processes simultaneously, controlling for the effects of each other.[22 27 28]

Since the inception of this methodology in 2001, about 200 papers studying co-evolution of network ties and different behaviours have been published. The possibility of performing a meta-analysis on SAOM papers has been demonstrated very recently by Gallupe et al, who analysed peer influence in offending behaviour.[29]

The range of health risk behaviour, including drinking, among adolescents, has been studied in the framework of longitudinal network design with subsequent SAOM analysis,[23 30 31] and it is worth noting that some studies pay special attention to age and gender differences in the effects of peer influence.[32 33]

The aim of the present study is to conduct a systematic review and meta-analysis of SAOM studies in order to examine the relative contribution and directionality of peer influence on alcohol consumption by adolescents. Taking into consideration that susceptibility of adolescents to peer influence depends on age and gender,[14–18] these two variables are of special interest for our study.

METHODS

We have prepared the current protocol in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) guideline (online supplementary file 1).[34] The start and end dates of the project of our systematic review and meta-analysis are 01 December 2018–01 December 2019.

Study eligibility criteria

To select the relevant works, we have set a number of procedural criteria of the studies' design and method, type of analysed behaviour, and participants:

1. The study should conduct an analysis of longitudinal data using SAOM. The number of data collection waves is not a limitation provided that there are at least two waves.
2. The study should explicitly measure social ties between adolescents (friendship ties, romantic ties, support ties and so on).
3. The behaviour modelled in SAOMs should be alcohol consumption. Specifically, the outcomes may be any of the following: drinking quantity, drinking frequency,

binge drinking, drunkenness, onset to first alcohol use, lifetime alcohol use.

4. The target population should be children and adolescents from 10 to 19 years old.

5. The study manuscript should be available by September 2019 when the updated database searches will be conducted.

Information sources and search strategy

The current research collects and analyses studies published in academic journals, dissertations/theses, reports, conference materials. The articles will be searched in the following electronic databases: Web of Science, Scopus, PubMed, The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL), EBSCOhost (MEDLINE, SocINDEX, Academic Source, ERIC), ProQuest (ProQuest Dissertations and Theses Global), PsycINFO (PsycNET), Excerpta Medica database (Embase) and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The search will include titles and abstracts. We will use Google Scholar for control, but not as the main electronic database; rather, we will use it to check for unpublished studies and grey literature. This procedure will allow us to correct our search query if needed.

Search query will consist of three points that match the research question: drinking behaviour, SAOMs and adolescents, and will be formulated with the inclusion of the maximum number of synonyms corresponding to these three points. Previously conducted systematic reviews on similar topics will help to formulate accurate queries.

Point 1 'Drinking behaviour': drink* OR alcohol* OR booze OR tipple and other synonyms, as well as types of beverages—liquor OR wine OR beer, etc. We will also include 'Substance Abuse' to collect a wider selection of studies dedicated to drinking among adolescents.

Point 2 'Analytical approach': SAOM* OR 'stochastic actor-oriented' OR The algorithm Simulation Investigation for Empirical Network Analysis in R (RSIENA) OR 'stochastic actor-based' OR 'simulation investigation for empirical network' and other possible variations of the method name.

Point 3 'Adolescents': adolesc* OR youth OR 'young person' OR teen* OR student* OR 'peer group' OR child* OR pupil and other synonyms.

After the search query has been tested on Web of Science and Scopus, it will be adapted for other search engines. If the request is modified, another search will be conducted through all the electronic databases. All of the changes will be discussed by the research team.

After forming our database of articles, according to the inclusion criteria, the references will be cross-checked for possible relevant studies not found by the above search queries.

An example of a full electronic search strategy for the Web of Science is given in online supplementary file 2.

Study selection process

The selection process will be conducted by three members of the research team independent of each other.

First, after deleting duplicate articles from the lists retrieved from all electronic databases, three reviewers will make independent decisions on whether the article should be included based on its brief description. Each article will be classified as 'relevant', 'irrelevant' or 'unclear'. Articles classified as 'unclear' by at least one team member will be discussed by the research group. Articles classified as 'irrelevant' by two team members will be deleted.

In the second step, three reviewers will carefully examine the full texts of the remaining relevant articles, make independent decisions on the methodological quality of the studies and conclude whether the studies should be included in the meta-analysis. Disagreements about disputed cases will be resolved through general discussion.

Data collection process

The data collection form will be created and piloted through several iterations in the course of reviewing a sample of primary studies. When the data collection form is finalised, two reviewers will independently extract data from each eligible study, duplicating each other's work. Duplication is needed to reduce errors in data extraction. The third reviewer will compare the duplicate extractions, and all discrepancies will be resolved through general discussion. If multiple reports of the same study will be identified, only one extraction will be kept. Such identification can be done by comparing the records of these studies and finding identical project names, datasets, characteristics of the study design, samples or model specifications. In case of missing or incomplete information (ie, participants demographics or missing data treatment), authors of primary studies will be contacted (up to three email attempts per study).

Data items

The following data will be extracted from the selected articles:

1. Bibliometrics: authors, name, source, year of publication, language and country. Bibliometric data will be generated automatically and checked for consistency by the members of the research team.

2. Characteristics of the study: country(s) and year when the study was conducted, project, dataset, type of sample (general, high risk, other), sample size (number of participants and number of networks), gender composition of the sample, age of participants and socioeconomic status of participants.

3. Study design: number and frequency of survey waves, data collection techniques, name generator questions.

4. Description of 'alcohol drinking behaviour': drinking quantity, drinking frequency, binge drinking, drunkenness, onset to first alcohol use, lifetime alcohol use; scale assessing the frequency/intensity of alcohol consumption, the type of alcoholic beverage, etc.

5. Descriptions of covariates included in the model: gender, age, family socioeconomic status and so on.

6. Description of participant dropout from wave to wave, description of missing data, treatment of missing data.
7. Model specifications.
8. Effect size data: parameter coefficients and SEs for selection effects, influence effects, behaviour dynamics effects, network structural effects.

Primary outcome

Estimation of the effect size of peer influence on alcohol consumption behaviour among adolescents of different age groups.

Quality assessment and risk of bias

Careful reviewing of available risk of bias assessment tools and quality assessment checklists revealed that none of them are applicable to non-experimental, longitudinal panel network studies.[35 36] We do not expect high heterogeneity between studies as every eligible study should employ the same methodology; nevertheless, the important characteristics of study design and implementation may differ considerably. We devised a custom checklist of study characteristics to evaluate the quality of each study: the number of networks, the number of participants, response rate, attrition rate, the percentage of missing data, treatment of missing data, study limitations. The checklist will be pilot-tested with a few articles and modified before quality evaluation. When the checklist is finalised, two reviewers will independently evaluate each eligible study. If there is insufficient detail reported in the study, we will contact the primary study authors for more information (up to three email attempts per study). Disagreements will be resolved by general discussion.

While the sample size is important for statistical power, it is not a source of bias. Missing data, on the other hand, if not treated properly, would have a significant impact on research findings. One of the problems that emerge while working with longitudinal network data is the loss of a network agent due to attrition. Other reasons for missing data are item non-response and tie non-response. However, up to 10% of missing data does not lead to biased estimates as RSIENA package includes a data recovery procedure that replaces missing data using information from the previous or next wave or the global average.[27] Though imputation reduces the risk of bias in evaluating effects, we will closely monitor the percentage of missing data reported in primary studies.

Data synthesis

If a sufficient number of studies using SAOM are found, we plan to extract model results from individual articles and to conduct a meta-analysis. A meta-analysis of SAOM results is straightforward because parameters coefficients are presented as log odds ratios and require no further conversion. However, in SAOM there are different effects for testing peer influence (average similarity, total similarity, average alter) that are not directly comparable. Hence, we will need reasonably similar models, which further narrows our base for meta-analysis.

Since for some age groups there might not be enough research available, we will need to merge some age categories of adolescents. We may need to consult child psychologists so as to make an informed decision on merging some of the age categories.

For assessing heterogeneity of individual studies, we will use tau squared calculated in metafor package.[37 38] For meta-regression, we will use either robust variance estimation in robumeta package[39] or multilevel model in metafor package.[29 38]

Post-hoc sensitivity analyses will be conducted to explore whether covariates (age, gender composition) or choice of outcome measure (specific drinking behaviour) could explain observed heterogeneity in results.

Patient and public involvement

Patients and/or the public are not involved in the current study.

ETHICS AND DISSEMINATION

The current study is based on secondary data and does not require ethical approval. A list of all the studies included in this work will be available for review.

This study will be the first systematic review and meta-analysis to focus on rigorous analysis of peer influence in adolescent drinking behaviour. We plan dissemination in a peer-reviewed international scientific journal and through conference presentations. We expect the results of our study to be informative for researchers of childhood and adolescence, public health researchers and practitioners. The results of the research will provide guidance for developing effective prevention and intervention programmes.

Strengths and limitations

The fundamental strength of the proposed systematic review/meta-analysis is the fact that it is based on articles using rigorous methodology allowing the separation of peer influence from peer selection in the range of adolescent alcohol consumption behaviour. 'Social contagion' with harmful habits has been a popular research topic, and many researchers have attempted to evaluate peer influence in health risk behaviour. Recently, several review articles summarise the findings in this area.[24–26] However, the papers reviewed have used a variety of methods, none of which allows separation of the effects of peer influence from the confounding effects of peer selection.

Traditional tests of peer influence suffer from 'projection bias', that is, the tendency for people to overestimate the similarity between their behaviours and those of their peers and from the inherent entanglement of two processes: social influence and social selection. The only method (SAOM) able to isolate selection and influence was designed explicitly for this purpose less than 20 years ago.[28]

The SAOM method requires network data and longitudinal surveys, which are quite difficult to implement. Nevertheless, more and more papers employing this methodology are appearing. Papers using longitudinal network data and SAOM analysis will be collected and reviewed.

A possible limitation is that not enough articles for meta-analysis will be found. Our inclusion criteria imply specific age of adolescents (10–19 years old). A second limitation is that the models for meta-analysis should be sufficiently similar. SAOM allows modelling of different peer effects (average similarity, total similarity and average alter) that may not yield similar interpretations. Moreover, structural effects included in the model may also differ; therefore, we will extract data for meta-analysis from studies that use comparable model specifications.

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