A Systematic Review of the Effects of Alcohol on Emotion Recognition

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Abstract
Aims. Alcohol has been linked to both positive (e.g., sociability) and negative (e.g., aggression) social outcomes; however, specific mechanisms that contribute to these alcohol-induced social outcomes remain unclear. Alcohol-induced changes in emotion recognition may enhance social experiences, and contribute to the development of social problems. This study aims to 1) systematically review alcohol administration studies to clarify effects of alcohol on emotion recognition, and 2) review potential moderators.
Methods. PsycINFO, PubMed, and Google Scholar were searched following a pre-registered PROSPERO protocol (CRD42021225392) and PRISMA methodology. Analyses focused on differences in emotion recognition between participants consuming an alcoholic and/or a non-alcoholic (i.e., placebo or no-alcohol control) beverage.
Participants. 14 studies (all with unique samples; *N*=996 participants)
Measures. Data were extracted for sample demographics, alcohol administration methods, and emotion recognition tasks/outcomes.
Conclusions. No consistent effects of alcohol on emotion recognition emerged for any emotions. Moderating variables (e.g., alcohol dosage(s), emotion recognition tasks) were also unclear. Further research is needed to clarify the underlying mechanisms explaining alcohol's effects on positive and negative social behaviors. This knowledge may help our understanding of alcohol-induced social costs, which may inform prevention and intervention approaches, and may provide support to theories focused on alcohol's social rewards.

Systematic Review of the Effects of Alcohol on Emotion Recognition

Alcohol has both "prized and dangerous effects" [1]; alcohol use can cause social problems, but also act as a powerful social lubricant. On the one hand, alcohol has been linked to negative social outcomes (e.g., increased aggression and interpersonal violence), reflecting the extreme social costs that alcohol use can have [2]–[5]. However, alcohol has also been shown to induce strong social facilitate effects [6], reflected by increased social bonding and sociality, and greater perceived physical attractiveness of others [7]–[11]. Indeed, these desirable social outcomes have been implicated in the development of alcohol problems, as individuals may increase their drinking because of these powerful social rewards [12]. Notably, though, despite strong evidence of the existence of both negative and positive alcohol-induced social outcomes, the mechanisms that contribute to these effects remain unclear.

Alcohol-induced changes in emotion recognition, or the ability to accurately identify emotions in others [13], may contribute to the development of social problems (e.g., by impairing the ability to see distress cues like sadness in others [14]) and help to explain alcohol's ability to enhance social experiences (e.g., by boosting the ability to see positive emotions in others [15]). Accurate emotion recognition plays a key role in adaptive social functioning and social interactions [16]–[19], is linked to psychosocial skills, and provides a basis for social communication and emotional functioning within relationships [13], [16]–[18], [20]–[23]. Thus, emotional content may have an important functional use for navigating social situations as it provides useful information to facilitate effective and applicable communication [19]. Disruptions in the ability to accurately identify emotions in others while intoxicated may have important social consequences (e.g., [14]).

Experimental alcohol administration studies offer researchers a methodologically rigorous approach to investigate the effects of alcohol on emotion recognition. In these studies, participants are either randomly assigned to consume an alcoholic or non-alcoholic (i.e., placebo and/or control) beverage (i.e., a between-subjects design), or participants consume both an alcoholic and non-alcoholic beverage (i.e., a within-subjects design). Participants' responses on facial emotion recognition tasks are then contrasted across beverage assignment (e.g., [15], [24], [25]). Commonly, researchers draw upon the appraisal-disruption model [26] to explain the acute effects of alcohol on emotion recognition (e.g., [24], [25], [27]). According to this theory, alcohol impairs a person's ability to encode new emotional content and impedes integration with events stored in long-term memory, thereby altering judgments and behavioral responses based on the emotional content of stimuli (e.g., [24]). However, the growing literature on alcohol's effects on emotion recognition reveals inconsistent applications of this theory and mixed findings, offering little clarity to the ways in which alcohol affects the ability to recognize emotions in others. Specifically, some researchers argue that the positive social effects of alcohol result from the enhanced recognition of positive emotions and/or the impaired recognition of negative emotions following intoxication (e.g., [15], [25]). These changes may lead to an increase in positive affect and/or a decrease in negative affect, which may facilitate social behaviors that serve as mechanisms for increased sociability [24], [25], [28]. For example, the enhanced ability to detect happiness in others and/or the reduced ability to identify anger while intoxicated may contribute to or explain alcohol's social rewarding effects, like increased social bonding (e.g., [15], [29]).

Other researchers argue that alcohol consumption may lead to an increased likelihood of inappropriate behavioral responses, such as increased aggression (e.g., [24]), due to deficits in recognition accuracy and/or misattribution of negative emotions (e.g., [30], [31]). For instance, the inability to accurately identify distress cues (e.g., fearful or sad expressions) in others may increase the likelihood of reacting inappropriately towards those individuals by decreasing the promotion of prosocial behaviors and increasing the likelihood of aggression [29]. Researchers have also argued that acute increases in the tendency to perceive negative emotions (e.g., anger) and/or misattribute emotions (e.g., mistaking neutrality as anger) in others while intoxicated may help to explain many of the negative social consequences of alcohol use, including aggression (e.g., [24], [25], [32]).

Thus, two predominant lines of thinking exist in the literature on alcohol's effects on emotion recognition. Researchers have theorized that alcohol both increases the perception of negative emotions in others, which is offered as a mechanism for undesirable social outcomes (e.g., increased aggression) (e.g., [24]), and increases the perception of positive emotions in others, which is thought to be a mechanism for increased sociability (e.g., [15]). And while some researchers acknowledge that emotion recognition may contribute to both positive and negative alcohol-induced social effects (e.g., [25]), the findings are mixed and inconsistent. For instance, some studies found that alcohol caused deficits in recognition of sad expressions, but not happy or angry expressions [25], [32]. Others reported an improved ability to identify happiness [15] and disgust and contempt [33] after alcohol consumption. Taken together, it is unclear whether alcohol reliably impacts emotion recognition and, if so, what the specific nature of these effects are.

Given the mixed and inconsistent findings in the literature, as well as competing hypotheses offered by researchers, the current paper aims to systematically review results from alcohol administration studies investigating the effects of alcohol on emotion recognition. These studies varied substantially in their methodology (e.g., using different emotion recognition tasks, testing recognition of different emotions, giving a range of alcohol dosages, and assessing several different outcome variables). Thus, a systematic review was selected as a meta-analysis would be inappropriate with such varied methods and outcome variables [34], [35]. We aim to clarify the effects of alcohol on the recognition of positive (e.g., happiness) and negative (e.g., anger) emotions, and to consider potential moderators (e.g., participant gender, alcohol dosage) of these effects. To our knowledge, this is the first study to do so. By investigating whether and in what ways (i.e., improvement vs. impairment) alcohol impacts emotion recognition, the results from this study may identify mechanisms underlying the social costs of alcohol consumption (e.g., increased aggression) [2] and alcohol's desirable social effects [12]. This study, therefore, holds the potential to inform 1) prevention and intervention efforts aimed at reducing negative alcohol-related consequences, and 2) theories of alcohol use focusing on alcohol's socially enhancing effects.

Method

We report methodology in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [Moher, 2009]. The full review protocol is available in International Prospective Register for Systematic Reviews (PROSPERO); (http://www.crd.york.ac.uk/PROSPERO/, registration no. CRD42021225392).

Literature searches were conducted in March 2021 and again in February 2022 using the databases PubMed, psycINFO, and Google Scholar to identify relevant studies published since 1970, with search terms including [alcohol] AND [emotion recognition OR emotion expression OR facial expression recognition]. Searches were limited for two of the databases such that keywords had to appear in the title for Google Scholar searches and in the title or abstract for psycINFO searches. The reference lists of identified studies were also scanned, and reverse searches were generated and scanned for appropriate studies. To be included in the review, studies were required to 1) use an alcohol administration protocol in a between- or within-subjects design, in which participants consumed an alcoholic and/or non-alcoholic (i.e., placebo and/or control) beverage, and 2) include at least one measure of emotion recognition as an outcome variable. Exclusionary criteria included non-human animal, non-English language, non-peer reviewed/unpublished, and clinical population (e.g., patients with social phobia) studies.

Data extraction and coding

We extracted information for the following variables: sample characteristics (e.g., college vs. community sample, mean age of the sample, sample sizes), study designs and blinding procedures (e.g., within- or between-person design, comparison groups (i.e., placebo and/or control]), manipulation checks), alcohol administration procedures (e.g., dosage(s) of alcohol administered), emotion recognition tasks, and emotion recognition outcome variables. A second member of the study team independently extracted data, and two additional members of the lab separately checked the extracted data for accuracy against the original articles. The few discrepancies that existed were reconciled by team discussion.

Quality Assessment

A modified version of the Quality Assessment Tool for Quantitative Studies (QATQS) was adapted to assess design quality for each included study (see Supplementary Scale 1). Two members of the study team independently rated study quality for each study, and any differences were resolved through team discussion.

Results

A total of 321 articles were initially identified in the search. Twelve articles, including 14 unique samples/studies[1] and 996 individuals, were included in the systematic review (see Figure 1 for exclusions and reasons).[2] The average study quality rating was 1.53 (SD=0.52), suggesting a moderate quality (see Table 1). Moderate quality studies typically included information on participant selection (e.g., representativeness), adjusted for some confounders in analyses (e.g., age, gender), detailed randomization and blinding procedures, clearly stated their hypotheses, and detailed inclusion/exclusion criteria. Studies that received weak scores typically failed to report sufficient information on these factors, such as providing unclear randomization and blinding procedures. Eight studies received a moderate score [24], [25], [28], [32], [36], [39], [40], while the remaining six studies received a weak score [15], [27], [29], [33], [37].

Sample Characteristics

Sample characteristics are displayed in Table 1. Final sample sizes ranged from *n*=15 [28] to *n*=189 ([36], see Study 2) with an overall mean sample size of 71.14. One study included only male participants [28], while the remaining studies included both males and females [15], [24], [25], [27], [29], [32], [33], [36], [37], [39], [40] (see Table 1 for gender breakdown by individual studies). All studies (*n*=14) included young adults with sample mean ages ranging from 21 years ([36], see Study 1) to 25.9 years [28], and all (*n*=14) enlisted social drinkers to participate. The majority of studies (*n*=9) recruited participants from universities and the local communities [24], [25], [29], [32], [36], [37], [39]. Three studies recruited only from universities [15], [27], [33], one study recruited only from the local community [40], and the final sample did not specify how participants were recruited [28]. Eight studies were conducted in the United

[1] Two articles included two studies comprised of two unique samples each [36], [37]

[2] One article satisfied initial inclusion criteria, but was later excluded due to insufficient reporting of results [38]

Kingdom [24], [25], [29], [32], [33], [36], [39], [40], two studies were conducted in Israel [37], one study was conducted in Switzerland [15], one study was conducted in Australia [29], one study was conducted in Japan [28], and one study was conducted in Germany [27] (see Table 1 for study location by individual study). Only two of the 14 studies provided racial and ethnic data for participants, such that all participants for one study were of European-Caucasian background [15] and all participants for the second study were of Japanese background [28].

Study Design and Blinding Procedures

Design procedures of the studies are described in Table 1. The majority of studies (*n*=8) employed a between-subjects design, comparing emotion recognition abilities in individuals who were randomly assigned to consume alcohol to individuals who were randomly assigned to consume a placebo beverage [25], [27], [29], [32], [36], [37], [40]. The remaining studies *(n*=6) used a within-subjects design, such that each participant was exposed to every beverage assignment (i.e., alcohol and placebo) [15], [24], [28], [33], [37], [39]. Of these six studies, four studies counterbalanced the drink order [15], [28], [33][39], one study randomly assigned drink order [24], and one study used a fixed drink order [37], in which participants first drank a placebo beverage followed by three alcoholic beverages (i.e., 0.3, 0.6, 0.9 g/kg) [37] (see Study 2). None of the studies included a no-alcohol control beverage. The most common blinding technique (*n*=10) was a double-blind procedure (i.e., both experimenter and participant were blind to alcohol vs. placebo assignment) [15], [24], [25], [27], [32], [36], [37], [39], [40]. Four studies used single-blinding procedures (i.e., only participants were blind to beverage assignment) [15], [28], [33], [37].

Seven (50%) studies reported on manipulation checks for the placebo deception [25], [27], [29], [36], [39], [40]. Of these seven studies, five reported that fewer participants in the placebo group believed they had consumed alcohol compared with participants who were assigned to consume alcohol [25], [27], [36], [39]. One study found that participants in the placebo group believed they consumed fewer standard drinks than those assigned to consume alcohol [29]. The final study reported no significant difference between participants in the placebo group compared to participants in the alcohol group on guessing whether they consumed alcohol or placebo beverages [40]. The remaining studies (*n*=7) did not report manipulation checks for placebo deception [15], [24], [28], [32], [33], [37].

Alcohol Administration Procedures

Alcohol dosages ranged from 0.14 g/kg to 0.9 g/kg (see Table 2 for alcohol dosages for each study). The majority of studies (*n*=11) used a dose of alcohol in the 0.14 g/kg to 0.6 g/kg range [15], [24], [25], [27], [28], [32], [33], [36], [37], [39], [40]. Three studies used a higher (e.g., 0.8-0.9 g/kg) dosage of alcohol [29], [37], [40]. Eleven studies based alcohol dosages on participants' body weight [15], [24], [27]–[29], [33], [36], [37], [39], while the remaining three studies did not specify body weight measurement collection prior to beverage consumption [25], [32], [40]. Four studies additionally adjusted alcohol doses based on participant sex [15], [33], [37], and three additionally accounted for participant height [29], [37].

Seven (50%) studies gave participants 10 minutes to consume the assigned drink [28], [29], [36], [37], [39], with the highest length of time for drink consumption being 30 minutes [40]. Only one study did not specify the time interval for drink consumption [27]. The time interval between post-drink consumption and the start of the emotion recognition task ranged from 10 minutes (*n*=5) [27], [36], [39], [40] to 30 minutes [28], which is in line with research suggesting that participants were on the ascending limb of alcohol absorption when these tasks were completed [41]. Four studies did not specify the time interval between post-drink consumption and the start of the emotion recognition task [24], [25], [29], [32]. One study implemented a cumulative drinking design such that each participant received a total of four beverages consumed in sequential order (i.e., no-alcohol placebo, 0.3, 0.6, and 0.9 g/kg of alcohol) during a single drinking session, and completed an emotion recognition task 20 minutes after each drink ([37], see Study 2).

Emotion Recognition Tasks, Outcomes, and Reliability Estimates

Emotion recognition tasks used across studies are described in Table 2. All studies used tasks that asked participants to identify emotions from images or videos of facial expressions. Ten of the 14 studies presented stimuli with both male and female actors displaying the emotions [15], [24], [25], [27]–[29], [32], [37], [40], while the remaining four studies used only male actors to display emotions [33], [36], [39]. Only three studies provided information on the race of the actors used to display emotions. Two studies reported that the actors were Caucasian [29], [33], and one study reported that the actors were Japanese [28].

As shown in Table 2, two types of emotion recognition tasks have been employed by researchers. The first type, which was used by 13 of the 14 studies, captured an individual's ability to *identify a specific emotion* (e.g., happiness) from facial expressions [15], [24], [25], [27]–[29], [33], [36], [37], [39], [40]. One of these studies varied the presentation of facial expressions by time such that following a static neutral expression, a static micro-expression (i.e., 200ms presentation) or a static longer-expression (i.e., 400ms presentation) of an emotional state (e.g., sadness) was shown [33]. The outcomes measured by this study included *accuracy* (i.e., score for correct emotion identifications from facial expressions) and *reaction times* (i.e., the amount of time that elapsed between when the stimulus was first presented and the point at which an emotion was identified from that stimulus). The remaining 12 studies presented emotions according to a morphed continuum/sequence of faces [15], [24], [25], [27]–[29], [36], [37], [39], [40]. Three of these 12 studies presented the sequence of faces as video clips [27], [29], [40], the remaining studies (*n*=9) presented the sequences as static images of facial expressions [15], [24], [25], [28], [36], [37], [39]. Nine out of these 12 studies presented facial expressions that increased in intensity from a neutral expression (i.e., standard stimulus with no emotional content) to a full emotional exemplar (e.g., happiness) [15], [24], [25], [27]–[29], [37], [40]. Outcomes measured for these tasks included the following: accuracy (*n*=4) [27], [29], [37], [40], reaction times (*n*=3) [27], [28], [40], *threshold detection* (i.e., the point at which an emotion is identified from stimuli containing varying amounts of emotional content) (*n*=3) [15], [24], [25], *false alarms* (i.e., the number of incorrect identifications of an absent emotion) (*n*=1) [40], *neutral-response errors* (i.e., incorrect identification of an expression of a specific emotion (e.g., sadness) as neutral) (*n*=1) [40], *response sensitivity* (i.e., the ability to discriminate the presence of a specific emotion from a stimulus) (*n*=1) [40], *response bias* (i.e., the tendency to see a specific emotion even when it is not there) (*n*=1) [40], and *error ratios* (i.e., the proportion of correct and incorrect responses for identifying a specific emotion from facial expressions) (*n*=1) [28]. Three of these 12 studies presented facial expressions that increased in intensity from an ambiguous expression (i.e., composite image averaging exemplars for each emotional expression) to a full emotional exemplar (e.g., anger) [36], [39]. Outcomes measured by these tasks include: response sensitivity (*n*=1) [39], response bias (*n*=1) [39], accuracy (*n*=2) [36], and false alarms (*n*=2) [36].

The second type of task employed by researchers captured *emotion recognition biases*, or the tendency to see a specific emotion (e.g., happiness) over another emotion (e.g., anger). One study measured only emotion recognition bias [32], while an additional two studies measured both the ability to discriminate a specific emotion from facial expressions and emotion recognition bias [36], [39]. All three studies employed a task that presented facial expressions that ranged from one emotional endpoint (e.g., anger) to a second emotional endpoint (e.g., happiness). The outcome for this task is called the *balance point*, or the point along the continuum where a subject is equally likely to identify an image as either of the two emotional endpoints (e.g., angry/happy). Balance points that fall close to one end of the spectrum (e.g., a threshold closer to angry vs. a threshold closer to happy) rather than the middle range (i.e., 50%) indicate a recognition bias for that emotion.

Notably, only one study reported reliability estimates for emotion recognition task outcomes [40], such that reliability for *reaction times* to identify different facial expressions was estimated to be (α=0.97–0.98). Reliability estimates were not reported for any of the outcome measures in the remaining 13 studies [15], [24], [25], [27]–[29], [32], [33], [36], [37], [39].

Effects of Alcohol on Recognition of Happiness

As shown in Table 2, 12 studies (published in 11 articles) compared participants' responses while consuming alcohol versus placebo on the recognition of happy facial expressions [15], [24], [25], [27]–[29], [33], [36], [37], [39], [40]. Three studies found that recognition of happy expressions significantly improved following alcohol consumption compared to placebo [15], [36], [37]. One of these [37] reported on a second study that used a cumulative-drinking design, in which participants consumed multiple beverages in sequential order (i.e., 0.0, 0.3, 0.6, and 0.9 g/kg of alcohol) and completed the emotion recognition task after each beverage (see Study 2). When comparing results across studies (i.e., single-dose procedure vs. cumulative-dose procedure), they found that participants who consumed a single higher dose (0.9 g/kg) of alcohol were significantly less accurate on happy recognition than participants assigned to the cumulative-drinking procedure who eventually drank 0.9 g/kg of alcohol [37] (see Study 2). Another study found that a higher dose (0.56 g/kg) of alcohol significantly improved recognition of happy expressions compared to a lower dose (0.14 g/kg) of alcohol [28]. One study found the opposite effect, such that recognition of happy expressions was significantly impaired following alcohol consumption compared to placebo [39]. The remaining seven studies found no effect of alcohol (vs. placebo) on recognition of happy expressions [24], [25], [27], [29], [33], [36], [40]. One study that did not find an effect of alcohol (vs. placebo) on happy recognition found that females had faster reaction times compared to males, regardless of drinking condition (i.e., alcohol vs. placebo) [40].

No discernable patterns emerged across studies that did and did not find significant effects of alcohol on recognition of happy facial expressions. For instance, a mix of between- and within-subjects designs were used and a range of alcohol dosages were tested in studies that did (i.e., 0.14 g/kg to 0.9 g/kg) and did not (i.e., 0.2 g/kg to 0.8 g/kg) find effects of alcohol. While all of the studies that found an effect of alcohol tested participants on the ascending limb of alcohol absorption, four of the studies reporting null findings also tested participants on the ascending limb [27], [33], [36], [40]. The remaining three studies reporting null findings did not report information on when the emotion recognition task took place relative to alcohol consumption [24], [25], [29]. The tasks used by studies that found an effect of alcohol presented facial expressions that ranged from either neutral [15], [28], [37] or ambiguous [36], [39] expressions to a full emotional exemplar of happiness. However, studies reporting null findings also used tasks that ranged from either neutral (e.g., [27]) or ambiguous (e.g., ([36], see Study 2)) expressions to a full emotional exemplar of happiness. Further, while all studies that found an effect of alcohol presented a sequence of facial expressions as static images, four studies that found no effect of alcohol also presented a sequence of facial expressions as static images (e.g., [24], [25]). One difference between studies that did and did not find an effect of alcohol is that all of the studies that used video clips (*n*=3) found no effect of alcohol on happy recognition [27], [29], [40]. A variety of different outcomes were measured across studies that found an effect of alcohol, including: threshold detection [15], accuracy scores [37], false alarms ([36], see Study 1), reaction times [28], and response bias [39]. However, some studies that found no effect of alcohol measured these same outcomes, including threshold detection [24], [25] and reaction times (e.g., [33]). It is notable that across the studies that tested the effects of alcohol (vs. placebo) on happiness recognition, only 58% (*n*=7) of studies conducted manipulation checks to determine if the placebo deception was successful [25], [27], [29], [36], [39], [40], and only one of these studies was successful in the placebo deception [40] (i.e., the other six studies were unsuccessful in placebo deception [25], [27], [29], [36], [39]). The remaining studies (*n*=5) failed to conduct manipulation checks [15], [24], [27], [28], [33].

Effects of Alcohol on Recognition of Anger

As shown in Table 2, twelve studies (published in 11 articles) compared participants' responses while consuming alcohol versus placebo on the recognition of angry facial expressions [15], [24], [25], [27]–[29], [33], [36], [37], [39], [40]. Most studies (*n*=11) found no effect of alcohol on recognition of angry expressions compared to a placebo [15], [24], [25], [27]–[29], [33], [36], [37], [39], [40]. One study found that recognition of angry expressions was significantly impaired following alcohol consumption compared to a placebo (i.e., participants were less likely to see anger [36], see Study 1). One of the studies that did not find a main effect of alcohol on angry recognition [25] found that males showed significantly higher threshold values (i.e., impaired recognition) than females for angry expressions, independent of drink assignment (i.e., alcohol vs. placebo). This study further found that participants who expected placebo effects (i.e., told beverage was a placebo) had lower threshold values (i.e., improved recognition) for male-angry expressions than female-angry expressions compared with participants who expected alcohol (i.e., told beverage was alcohol). According to the manipulation check, though, placebo deception was unsuccessful in this study [25]. One of the studies that did not find a main effect of alcohol on angry recognition found that females had faster reaction times compared with males, regardless of drinking condition (i.e., alcohol vs. placebo) [40]. One of the studies that did not find a main effect of alcohol on angry recognition [37] (see Study 1) conducted a second study and found that participants who consumed a single higher dose (0.6 g/kg) of alcohol were significantly less accurate than participants who continuously consumed alcohol to a higher dose (0.6 g/kg) of alcohol for angry recognition, indicating that a single-dose procedure impairs anger recognition compared to a cumulative-drinking procedure at a higher dose (0.6 g/kg) of alcohol [37] (see Study 2).

No discernable patterns emerged across studies that did and did not find significant effects of alcohol on recognition of angry facial expressions. For instance, the one study that found an effect of alcohol employed a between-subjects design and used a moderate dose (0.4 g/kg) of alcohol [36] (see Study 1). However, six studies reporting null findings also used a between-subjects design [25], [27], [29], [36], [37], [40] and another six studies reported null findings using this same dosage (i.e., 0.4 g/kg) of alcohol [24], [25], [27], [36], [39], [40]. While the study reporting an effect of alcohol tested participants on the ascending limb of alcohol absorption, eight studies that did not find an effect of alcohol also tested participants on the ascending limb of alcohol absorption [15], [27], [28], [33], [36], [37], [39], [40]. The remaining three studies reporting null findings did not report information on when the emotion recognition task took place relative to alcohol consumption [24], [25], [29]. The task used by the study that found an effect of alcohol presented static images of facial expressions that ranged from ambiguous expressions to a full emotional exemplar of anger [36] (see Study 1). Two studies that found no effect of alcohol also presented static images of facial expressions that ranged from ambiguous expressions to a full emotional exemplar of anger [36], [39]. Further, six additional studies also presented facial expressions as static images [15], [24], [25], [28], [33], [37]. One difference is that all studies that presented video clips (*n*=3) found no effect of alcohol on angry recognition [27], [29], [40]. The outcome that revealed a significant effect of alcohol (vs. placebo) on angry recognition was false alarms for angry expressions. However, the two other studies that measured for angry false alarms report null findings [36], [40]. A variety of different outcomes, including threshold detection (e.g., [24]) and accuracy scores (e.g., [29]), were measured by studies reporting null findings. While the majority of studies (*n*=7) measuring angry recognition conducted manipulation checks to determine if the placebo deception was successful [25], [27], [29], [36], [39], [40], only one study that tested the effect of alcohol on angry recognition was successful in the placebo deception [40]. The remaining studies (*n*=5) failed to conduct manipulation checks [15], [24], [27], [28], [33] .

Effects of Alcohol on Recognition of Sadness

Eleven studies (published in 10 articles) compared participants’ responses while consuming alcohol versus placebo on the recognition of sad facial expressions [15], [24], [25], [28], [29], [33], [36], [37], [39], [40]. Three studies found that recognition of sad expressions was significantly impaired following alcohol consumption compared to placebo [25], [29], [39], and the remaining studies (*n*=7) found no effect of alcohol on recognition of sad expressions compared to placebo [15], [24], [28], [33], [36], [37]. One of these four studies that found an effect of alcohol (vs. placebo) on impaired sad recognition also found a main effect of gender, such that males had significantly higher threshold values (i.e., worse recognition of sad expressions) compared to females, regardless of drink assignment (i.e., alcohol vs. placebo) [25]. One of studies that did not find an effect of alcohol (vs. placebo) on impaired sad recognition found that males were particularly impaired (i.e., higher threshold values) on recognition of sad expressions compared to females at a 0.4 g/kg dose of alcohol [24]. Another study that did not find an effect of alcohol (vs. placebo) on sad recognition found that a lower dose (0.4 g/kg) of alcohol significantly impaired sad recognition compared to a higher dose (0.8 g/kg) of alcohol [40]. This same study found that females had faster reaction times compared with males, regardless of drinking condition (i.e., alcohol vs. placebo) [40].

No discernable patterns emerged across studies that did and did not find significant effects of alcohol on recognition of sad facial expressions. For example, a mix of between and within-person designs were used and a range of alcohol dosages were tested in studies that did (i.e., 0.2 g/kg to 0.8 g/kg) and did not (i.e., 0.14 g/kg to 0.9 g/kg) find effects of alcohol. Two of the five studies that found an effect of alcohol on sad recognition did not report information on when the emotion recognition task took place relative to alcohol consumption [25], [29]. The remaining two studies that found an effect of alcohol tested participants on the ascending limb of alcohol absorption [39], [40]; however, six studies reporting null findings also tested participants on the ascending limb of alcohol absorption [15], [28], [33], [36], [37] and one study did not report information on when the emotion recognition task took place relative to alcohol consumption [24]. The majority of studies that found an effect of alcohol (n=3) presented facial expressions that ranged from a neutral expression to a full emotional exemplar of sadness [25], [29], [40], while the fourth study presented facial expressions that ranged from an ambiguous expression to a full emotional exemplar of sadness [39]. Studies reporting null findings also used tasks that ranged from either neutral (e.g., [28]) or ambiguous [36] expressions to a full emotional exemplar of sadness. Tasks that presented facial expressions as static images were used by both studies that did [39], [40] and did not (e.g., [15]) find an effect of alcohol. One difference is that all studies that presented video clips (n=2) found an effect of alcohol on the recognition of sad expressions [29], [40]. A variety of different outcomes were measured across studies that found an effect of alcohol, including: threshold detection [25], response sensitivity [39], accuracy scores [29], and neutral-response errors [40]. However, some studies that found no effect of alcohol measured these same outcomes, including threshold detection [15], accuracy scores (e.g., [33]), and response sensitivity [36]. Of the 11 studies that compared sad recognition between alcohol and placebo assignment, six conducted manipulation checks to determine of the placebo deception was successful [25], [29], [36], [39], [40]. Only one of these studies successfully deceived participants on their beverage assignment [40], where this study found an effect of alcohol on sad recognition. The remaining studies (n=5) failed to conduct manipulation checks [15], [24], [28], [33], [37].

Effects of Alcohol on Recognition of Disgust

Seven studies (published in 6 articles) compared participants' responses while consuming alcohol versus placebo on the recognition of disgust facial expressions [15], [29], [33], [36], [39], [40]. Most studies (n=6) found no effect of alcohol on recognition of disgust expressions compared to placebo [15], [29], [36], [39], [40]. One study [33] found that disgust recognition significantly improved following alcohol consumption compared to placebo. This study further found that recognition of disgust was significantly better at a higher dose (0.6 g/kg for males, 0.52 g/kg for females) compared to a lower dose (0.2 g/kg for males, 0.17 g/kg for females) of alcohol for microexpressions (i.e., disgusted expression presented for 200ms). For longer-expressions (i.e., disgusted expression presented for 400 ms), disgust recognition significantly improved following alcohol consumption compared with a placebo; however, disgust recognition at a lower dose (0.2 g/kg for males, 0.17 g/kg for females) did not significantly differ from the placebo group.

No discernable patterns emerged across studies that did and did not find significant effects of alcohol on recognition of disgusted facial expressions. For example, the study that found an effect of alcohol employed a within-subjects design and used both lower dosages (0.2 g/kg for males, 0.17 g/kg for females) and higher dosages (0.6 g/kg for males, 0.52 g/kg for females) of alcohol. However, studies reporting null findings also used a range of lower and higher alcohol dosages (i.e., 0.25 g/kg to 0.8 g/kg), and two studies reporting null findings used a within-subjects design [15], [39]. While the study that found an effect of alcohol tested participants on the ascending limb of alcohol absorption, five studies that did not find an effect of alcohol also tested participants on the ascending limb of alcohol absorption [15], [36], [39], [40]. The remaining one study that did not find an effect of alcohol did not report information on when the emotion recognition task took place relative to alcohol consumption [29]. One difference between studies that did and did not find an effect of alcohol is that the study reporting an effect of alcohol varied presentation of images by time. Following a static neutral expression, a static micro-expression (i.e., 200ms presentation) or a static longer-expression (i.e., 400ms presentation) of an emotional state (i.e., disgust) was shown. All the studies reporting null findings presented emotions according to a morphed continuum/sequence of faces. However, three of the studies that did not find an effect of alcohol also presented neutral expressions that ranged to a full emotional exemplar of disgust [15], [29], [40] and four studies reporting null findings presented static images of facial expressions [15], [36], [39]. A second difference between the study that found an effect and those that did not is that all studies that presented the task as video clips for disgust recognition (*n*=2) found no effect of alcohol [29], [40]. The outcome that revealed a significant effect of alcohol (vs. placebo) on disgust recognition was accuracy for disgusted expressions. However, four studies that did not find an effect of alcohol also measured accuracy for disgust recognition [29], [36], [40]. Studies that did not find an effect additionally measured for various outcomes, including threshold detection [15] and reaction times [40]. Of the 7 studies that compared sad recognition between alcohol and placebo groups, five conducted manipulation checks to determine of the placebo deception was successful [29], [36], [39], [40]. Only one of these studies successfully deceived participants on their beverage assignment [40], where this study did not find an effect of alcohol on disgust recognition. The remaining studies (*n*=2) failed to conduct manipulation checks [15], [33].

Effects of Alcohol on Recognition of Fear

Eight studies (published in 7 articles) compared participants' responses while consuming alcohol versus placebo on the recognition of fearful facial expressions [15], [29], [33], [36], [37], [39], [40]. Most studies (*n*=5) found no effect of alcohol on recognition of fearful expressions compared to placebo [15], [33], [36], [40]. Three studies found that fear recognition was significantly impaired following alcohol consumption compared to placebo [29], [37], [39]. One of these three studies found a significant effect of alcohol (vs. placebo) at a higher dose (0.9 g/kg) of alcohol, but not at lower doses (i.e., 0.3 and 0.6 g/kg) of alcohol compared to placebo [37] (see Study 1). In this same study, participants who consumed a single dose (i.e., 0.3, 0.6, or 0.9 g/kg) of alcohol were significantly less accurate on fear recognition than participants who continuously consumed alcohol to these doses (i.e., 0.3, 0.6, and 0.9 g/kg) , indicating that a single-dose procedure impairs fear recognition compared to a cumulative-drinking procedure at a range of dosages of alcohol [37] (see Study 2).

No discernable patterns emerged across studies that did and did not find significant effects of alcohol on recognition of fearful facial expressions. For example, a mix of between- and within-subjects designs were used and a range of alcohol dosages were tested in studies that did (i.e., 0.4 g/kg to 0.9 g/kg) and did not (i.e., 0.17 g/kg to 0.8 g/kg) find effects of alcohol. One of the studies that found an effect of alcohol did not report information on when the emotion recognition task took place relative to alcohol consumption [29]. While the remaining two studies that found an effect of alcohol tested participants on the ascending limb of alcohol absorption [37], [39], all of the studies reporting null findings also tested participants on the ascending limb [15], [33], [36], [40]. The tasks used by studies that found an effect of alcohol presented facial expressions that ranged from either neutral [29], [37] or ambiguous [39] expressions to a full emotional exemplar of fear. However, studies reporting null findings also used tasks that ranged from either neutral (e.g., [15]) or ambiguous [36] expressions to a full emotional exemplar of fear. Further, studies that found an effect of alcohol presented expressions as either video clips [29] or static images [37], [39], though studies reporting null findings also presented expressions as either video clips [40] or static images (e.g., [33]). Two outcomes revealed a significant effect of alcohol (vs. placebo) on fear recognition, including accuracy [29], [37] and response sensitivity [39]. However, studies that did not find an effect of alcohol also measured for accuracy (e.g., [36]) and response sensitivity [40], among other outcomes like threshold detection [15] and reaction times (e.g., [33]). Of the 8 studies that compared fear recognition between alcohol and placebo groups, five conducted manipulation checks to determine if the placebo deception was successful [29], [36], [39], [40]. Only one of these studies successfully deceived participants on their beverage assignment [40], where this study did not find an effect of alcohol on fear recognition. The remaining studies (*n*=3) failed to conduct manipulation checks [15], [33], [37].

Effects of Alcohol on Recognition of Surprise

Five studies (published in 4 articles) compared participants' responses while consuming alcohol versus placebo on the recognition of surprised facial expressions [15], [28], [29], [36], where all studies found no effect of alcohol on surprise recognition. One of these studies found that females had faster reaction times compared with males, regardless of drinking condition (i.e., alcohol vs. placebo) [40].

Effects of Alcohol on Recognition of Contempt

One study compared participants' responses while consuming alcohol versus placebo on the recognition of contempt facial expressions [33]. This study found that for both micro- (i.e., 200 ms) and longer-expressions (i.e., 400 ms), a higher dose (0.6 g/kg for males, 0.56 g/kg for females) of alcohol resulted in significantly improved contempt recognition compared to a placebo. Among micro-expressions, a higher dose (0.6 g/kg for males, 0.56 g/kg for females) of alcohol resulted in significantly greater accuracy for contempt recognition compared with a lower dose (0.2 g/kg for males, 0.17 g/kg for females) of alcohol. Among longer-expressions, accuracy scores among a lower dose (0.2 g/kg for males, 0.17 g/kg for females) of alcohol were not significantly different from accuracy scores among placebo for fear recognition. No patterns could be determined between studies that did and did not find significant effects of alcohol on recognition of contempt facial expressions because no other study measured contempt recognition.

Effects of Alcohol on Emotion Recognition Biases for Angry-Happy Expressions

Three studies compared participants' responses while consuming alcohol versus placebo on emotion recognition biases along the spectrum from angry to happy expressions (or in the reverse, happy to angry expressions) [32], [36], [39]. All three studies found no significant effect of alcohol on emotion recognition biases along the spectrum from angry to happy expressions.

Effects of Alcohol on Emotion Recognition Biases for Angry-Disgust

One study compared participants' responses while consuming alcohol versus placebo on emotion recognition biases along the spectrum from angry to disgust expressions [32]. This study found a significant emotion x participant sex interaction on balance point scores, where males displayed significantly higher scores than females suggesting that males tended to identify disgusted expressions as angry compared to females, regardless of drink assignment (i.e., alcohol vs. placebo). No patterns could be determined between studies that did and did not find effects of alcohol on emotion recognition biases along the spectrum from anger to disgust because no other study included a measure of anger-disgust recognition.

Effects of Alcohol on Emotion Recognition Biases for Happiness-Sadness

One study compared participants' responses while consuming alcohol versus placebo on emotion recognition biases along the spectrum from happy to sad expressions and found no significant effect of alcohol on emotion recognition biases along the spectrum from happy to sad expressions [39].

Discussion

Understanding the mechanisms that underlie alcohol's negative social consequences (e.g., increased aggression [14]) and social rewards (e.g., increased social bonding [8]) may inform prevention and intervention efforts targeting alcohol-induced social problems, and support theories focused on explaining alcohol's social facilitative effects. The current paper systematically reviewed alcohol administration studies to clarify the effects of alcohol on the recognition of positive and negative emotions, as well as review potential moderators on these effects, in order to uncover potential mechanisms (i.e., recognition of specific emotions) for alcohol-induced social outcomes.

Fourteen studies, each comprised of a unique sample, were identified [15], [24], [25], [27]–[29], [32], [33], [36], [37], [39], [40]. Methodologies varied substantially across papers (e.g., alcohol dosage(s), emotion recognition tasks, outcome variables), and revealed a lack of data regarding reliability for emotion recognition outcomes. Overall, there is little evidence that alcohol consistently affects emotion recognition (reviewed in more detail below). Two main types of emotion recognition tasks were used across studies. The first type of task captured the ability to identify a specific emotion (e.g., happiness) from facial expressions, employed by thirteen studies [15], [24], [25], [27]–[29], [33], [36], [37], [39], [40]. The most common example task used morphed facial expressions from a neutral or ambiguous expression to a full emotional exemplar (e.g., fear). The second type of task captured the tendency to see a specific emotion (e.g., happiness) over another emotion (e.g., anger), employed by three studies [32], [36], [39]. Example tasks include presenting facial expressions that gradually morphed from one emotional endpoint (e.g., happiness) to a second emotional endpoint (e.g., anger). Results from these two types of tasks are summarized in the following sections.

Effects of Alcohol on Emotion Recognition Abilities

Tasks that measured the ability to identify a specific emotion (e.g., happiness) from facial expressions revealed no consistent effects of alcohol (vs. placebo) on emotion recognition for any specific emotion measured. Happiness [15], [28], [36], [37], sadness [25], [29], [39], [40], and fear [29], [37], [40] had the most support for alcohol (vs. placebo) impacting emotion recognition. However, these significant effects should be interpreted with caution, as the majority of studies found no effect of alcohol (vs. placebo) on emotion recognition of happiness [24], [25], [27], [29], [33], [36], [39], [40], sadness [15], [24], [28], [33], [36], [37], and fear [15], [33], [36], [39].

Among the studies that found an effect of alcohol (vs. placebo) on happy recognition [15], [36], [37], [39], discrepancies existed in exactly how alcohol impacted happy recognition. Three studies found that happy recognition significantly improved following alcohol consumption compared to placebo [15], [36], [37]. In line with these results, another study found that a higher dose (0.56 g/kg) of alcohol improved recognition of happy expressions compared to a lower dose (0.14 g/kg) of alcohol [28]. Prior research has shown that happy expressions can facilitate relationship-building by serving as indicators for positive and friendly social interactions (e.g., [42]–[45]), and promote positive impressions of others (e.g., [46], [47]). Thus, it is possible that the enhanced ability to detect happy expressions in others following alcohol intoxication may underlie positive alcohol-induced social effects (e.g., [15]), including increased social bonding (e.g., [8]). However, one study found the opposite effect, such that happy recognition significantly worsened following alcohol consumption compared to placebo [39]. Taken together, there is weak evidence that alcohol affects recognition of happiness and when effects do emerge, the direction of these effects is inconsistent.

All three studies that found an effect of alcohol (vs. placebo) on sad recognition found that recognition of sad expressions significantly worsened following alcohol consumption [25], [29], [39]. An additional study found that a lower dose (0.4 g/kg) of alcohol impaired recognition of sad expressions compared to a higher dose (0.8 g/kg) of alcohol [40]. Research has found that sad expressions can evoke feelings of sympathy [48] and compassion [49], [50], and further serve as distress cues to encourage prosocial behaviors (e.g., social support) (e.g., [51]). Therefore, the impaired ability to pick up on distress cues (e.g., sadness) while intoxicated may encourage inappropriate behavioral responses, including increased aggression (e.g., [29]). Negative social costs of alcohol, including aggression, may thereby result from deficits in sad recognition (e.g., [25]). However, only three of 11 studies found that alcohol impaired the ability to recognize sadness in others, providing only weak evidence that alcohol impacts sadness recognition.

All three studies that found an effect of alcohol (vs. placebo) on fear recognition found that recognition of fearful expressions significantly worsened following alcohol consumption [29], [37], [39]. Similar to sadness, fearful expressions serve as distress cues (e.g., [29]) and can evoke empathy and support from others (e.g., [52]). Thus, a decrease in the tendency to perceive fearful expressions following alcohol consumption may partially explain negative social outcomes, like aggression, due to inappropriate behavioral responses [29]. Even so, there is weak evidence that alcohol influences recognition of fearful expressions as only three of 8 studies reported significant impairment to fear recognition following alcohol consumption.

Anger recognition was measured across 12 studies [15], [24], [25], [27]–[29], [33], [36], [37], [39], [40], but only a single study found an effect of alcohol on recognition of angry expressions, such that alcohol (vs. placebo) significantly worsened the recognition of angry expressions [36]. Angry expressions have been associated with harmful intent that may put personal and group well-being at risk [53], which may encourage aggressive behaviors to protect personal resources [54] and relationships (e.g., [55]). However, results of this review show that alcohol has no consistent effect on the ability to identify anger from others’ facial expressions, suggesting that changes in the perception of anger in others is not a key mechanism explaining positive or negative social outcomes of alcohol consumption.

Regarding other negative emotions, few studies measured disgust (*n*=7) [15], [29], [33], [36], [39], [40] and contempt recognition (*n*=1) [33]. In one study, both disgust and contempt recognition significantly improved following alcohol consumption compared to placebo [33]. Contempt expressions have been linked with social rejection and exclusion [55] and have been found to provoke aggression [56]. Prior research has also categorized disgusted expressions as threatening interpersonal-cues (e.g., [57]), and have associated them with hostility [58]. Thus, these results may explain social costs of alcohol consumption, including aggression [33]. However, only one study [33] assessed contempt and the majority of studies that assessed disgust found no effects of alcohol [15], [29], [36], [39], [40]. Taken together, there is weak evidence for an effect of alcohol on disgust, contempt, and angry recognition; however, given that few studies measured disgust and contempt recognition, additional studies are needed to examine these constructs more.

All five studies that measured surprise recognition found no significant effects of alcohol (vs. placebo) [15], [28], [29], [36]. Notably, unlike other emotions (e.g., happiness [15]), researchers did not propose specific hypotheses linking surprise recognition to alcohol-induced social outcomes across papers. Prior research suggests that surprised expressions occur rarely (e.g., [59], [60]), and results from this review indicate that alcohol does not affect surprise recognition.

Effects of Alcohol on Emotion Recognition Biases

Three studies used a task that measured the tendency to see a specific emotion (e.g., happiness) over another emotion (e.g., angry) (i.e., emotion recognition bias; [32], [36], [39]).

All three studies varied expressions from anger to happiness (or in the reverse, happiness to anger), and all three studies found no significant difference in performance between participants who consumed alcohol and those who consumed a placebo beverage. One study measured biases between recognition of happy and sad expressions and found no significant effect of alcohol on performance [39]. These results vary from the broader literature on emotion recognition, which suggests that positive emotions (e.g., happiness) are easier to identify than negative emotions (e.g., anger, sadness) [61]. Specifically, happiness is easiest to identify, followed by sadness and then anger [62]–[65]. However, these findings are in line with most studies that found no effects of alcohol (vs. placebo) on happy, sad, or angry recognition as reviewed above (e.g., [24], [27], [33]). Finally, one study compared performance between alcohol and placebo conditions on a task that ranged from angry to disgusted expressions, and also found no effect of alcohol on performance [24]. Taken together, there is no evidence that alcohol affects the likelihood of perceiving one emotion over another.

Moderators for the Effects of Alcohol on Emotion Recognition Abilities

In the few instances that a number of studies found an effect of alcohol on recognition of a specific emotion (e.g., happiness), no discernable patterns emerged between studies that did and did not find significant effects of alcohol (vs. placebo) on emotion recognition. We considered a range of moderator variables, including study design, alcohol dosage, emotion recognition tasks, outcome measures, and participant gender. A mix of between-subjects and within-subjects designs were used across studies, and a large range of alcohol dosages were tested across studies. For example, similar ranges were used in studies that did (i.e., 0.14 g/kg to 0.9 g/kg) and did not (i.e., 0.2 g/kg to 0.8 g/kg) find an effect of alcohol on happy recognition (e.g., [15], [28], [40]). Emotion recognition tasks varied greatly across studies and there were no clear trends for which tasks consistently produced significant effects. Tasks that varied presentation of expressions from neutral or ambiguous expressions to a full emotional exemplar (e.g., sadness) found both significant effects and no effects of alcohol on emotion recognition, such as in the case of sad expressions (e.g., [25], [39], [40]). Presentation of expressions as video clips revealed no effects of alcohol for happiness, anger, sadness, disgust, and surprise [27], [29], [40]; however, significant results were found for fear recognition [29], [40]. Tasks that presented static images of facial expressions were used across studies that did and did not find effects of alcohol on emotion recognition, including for angry recognition (e.g., [24], [36]). Further, a variety of emotion recognition outcomes revealed significant alcohol effects. For instance, effects of alcohol were found on happiness recognition when using measures of threshold detection, accuracy scores, false alarms, reaction times, and response bias (e.g., [15], [37]); however, studies reporting null findings for happy recognition measured all of these same outcomes as well (e.g., [25], [33]). Thus, no clear moderation effects for alcohol's impact on emotion recognition emerged for study design, alcohol dosage, emotion recognition tasks, or outcome variables.

One study directly tested alcohol administration methods as a potential moderator of alcohol's effects on emotion recognition [37]. The authors found that single-dose procedures (i.e., when participants consumed one of the following beverages in a single session: 0.3, 0.6, or 0.9 g/kg) significantly worsened recognition of happy, angry, and fearful expressions compared with cumulative-dosing procedures (i.e., when participants consumed the following multiple alcoholic dosages in a single session: 0.3, 0.6, and 0.9 g/kg). However, participants in the cumulative-dosing procedure completed the emotion recognition task after each beverage, so it is possible that learning effects may explain these results. More research is needed to determine if alcohol administration methods (i.e., single vs cumulative-dosing procedures) moderate the effects of alcohol on emotion recognition.

Some studies tested for gender differences in emotion recognition, as well as interactions between gender and beverage assignment. Consistent with prior research suggesting that females perform better than males in emotion recognition tasks [66], [67]), one study found that females had faster reaction times compared to males for happy, sad, angry, disgusted, and fearful expressions, independent of drink assignment (i.e., alcohol vs. placebo) [40]. Similarly, another study found that males showed higher threshold values (i.e., worse recognition) for sad and angry expressions compared to females, independent of drink assignment (i.e., alcohol vs. placebo) [25]. While these results suggest main effects of gender, with females performing better than males, they indicate that alcohol affects males and females similarly. Two studies, however, found a significant interaction between participant gender and alcohol dose. In one study, males had significantly higher threshold values (i.e., worse recognition) for sad expressions compared to females at a dose of 0.4 g/kg, but not for 0.0 or 0.2 g/kg doses of alcohol [24]. In the other study, males who consumed alcohol were more likely to judge disgusted faces as being angry compared to males who consumed a placebo, but there were no differences for females [32]. Overall, there is a lack of consistent evidence that alcohol affects males and females differently in their abilities to recognize emotions in others.

Limitations and Future Directions

This is the first study to systematically review alcohol administration studies examining emotion recognition abilities, but there are limitations. First, although we attempted to be as inclusive as possible, some studies were screened out due to our inclusion criteria. Namely, we omitted two studies that administered alcohol to participants with social phobia [68], [69], as this population is likely different from the otherwise healthy social drinkers that were recruited in the 14 studies reviewed here. Second, we opted to do a qualitative systematic review rather than a quantitative systematic review (e.g., meta-analysis). As such, we were not able to provide quantitative estimates of effect sizes, which provides a more objective and definitive conclusion about the association between two variables. However, there was substantial variability in study designs and outcome variables, both of which limit the usefulness and appropriateness of formal meta-analysis (e.g., [70]–[72]). Third, many of the studies reviewed here could be more rigorous in many ways. For example, only half the studies conducted power analyses to determine required sample sizes to detect effects of alcohol [33], [36], [37], [39], [40], and it is thus possible that the other studies reviewed here were under-powered. Future studies should perform a priori power analyses to ensure sufficient sample sizes to detect effects of alcohol. Further, only one out of 14 studies reported reliability estimates for the emotion recognition outcome variable [40]. Reliability estimates for outcomes allow researchers to determine if the outcome measure will consistently produce the same values each time if no real change has occurred. This is important because consistency of outcome variables allow researchers to confidently make inferences from the results as they relate to the constructs studied (e.g., effects of alcohol on positive and negative emotion recognition), as opposed to conclusions based on features of undependable measures [73]. Future studies should report reliability estimates for emotion recognition outcomes. In addition, though theories and hypotheses for the effects of alcohol on emotion recognition commonly differentiate between positive vs. negative emotions, happiness was the only positive emotion measured across the 14 studies, compared to five negative emotions (i.e., anger, sadness, disgust, fear, and contempt) measured across studies. Future studies should measure recognition of other positive emotions as well, such as joy or contentment (e.g., [74]). Also, while all 14 studies compared alcohol recognition abilities to a placebo beverage, only half of the studies reported results for manipulation checks [25], [27], [29], [36], [39], [40], and only one study was successful in its deception [40]. Future studies should perform manipulation checks when including a placebo beverage, and efforts should be focused on increasing placebo deception. Finally, the majority of studies were conducted on Western populations (e.g., British, German), and only one of these studies reported on the racial/ethnic background of participants (i.e., all European-Caucasian) [15]. One study was an exception as it was conducted in an Eastern population (i.e., Japanese) [28]. Prior research suggests that drinking patterns and attitudes vary across cultures (e.g., [75]). Additionally, some research indicates that the ability to accurately identify emotions in others may be influenced by racial/ethnic identities of the perceiver and the perceived (e.g., [76], [77]). Thus, more studies that report on racial/ethnic breakdown of participants and actors used to display emotions in the stimuli, and that occur across a broader range of cultures, are needed to determine if alcohol's acute effects on emotion recognition are applicable to more diverse populations.

Conclusions

Many researchers have hypothesized that alcohol's effects on positive (e.g., increased sociality) and negative (e.g., increased aggression) social behaviors are mediated by alcohol-induced changes in emotion recognition (e.g., [15], [24], [25], [36]). We systematically reviewed alcohol administration studies and found no consistent effects of alcohol on emotion recognition of any emotions. Moderating variables (e.g., alcohol dosage(s), emotion recognition tasks) were also unclear. Further research is needed to clarify the underlying mechanisms explaining alcohol's effects on positive and negative social behaviors. Such knowledge may help our understanding of alcohol-induced social costs, which may inform prevention and intervention approaches, and may provide support to theories focused on alcohol's social rewards.

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram for studies selected for the systematic review

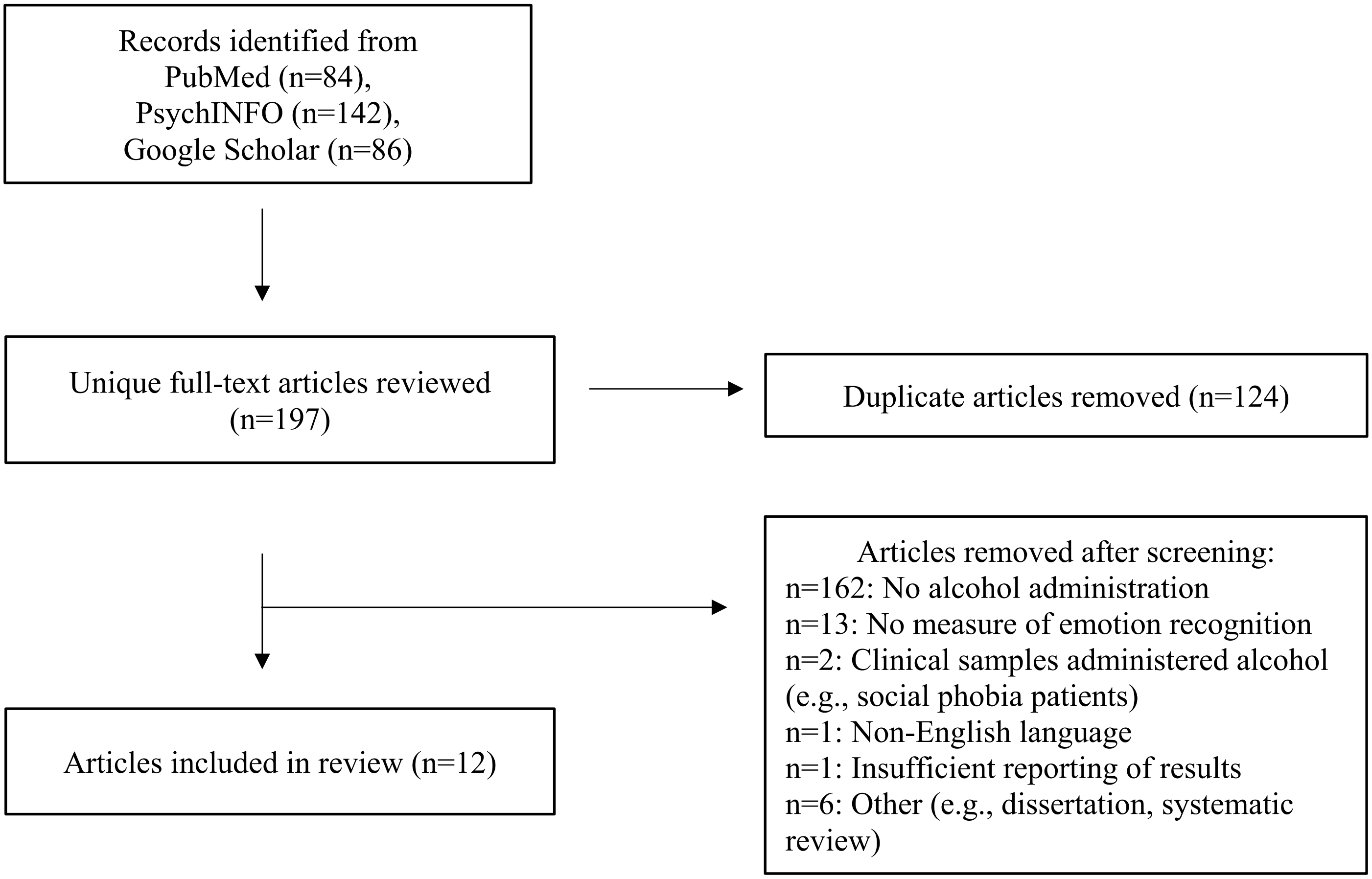

Table 1: General Study Characteristics

Study Authors	Location	Sample Characteristics			Experimental Conditions		
		N (Gender Breakdown)	*Age, years Mean (range)*	*Race/Ethnicity*	*Design*	*Blinding*	*Manipulation Check*
Attwood et al (2009)a [24]	United Kingdom	40 (50% male)	M=23 (19-38)	Not specified	Within-subjects, repeated measures	Double-blind	No
Attwood et al. (2009)b [32]	United Kingdom	80 (50% male)[a]	M=25[a]	Not specified	Between-subjects, independent groups	Double-blind	No
Craig et al. (2009) [25]	United Kingdom	97 (50% male)[a]	M=24 (18-40)[a]	Not specified	Between-subjects, independent groups	Double-blind	Yes
Dolder et al. (2017) [15]	Switzerland	60 (50% male)	M=25 (18-43)	100% European-Caucasian	Within-subjects, repeated measures	Double-blind	No
Eastwood et al. (2020) [39]	United Kingdom	88 (50% male)	M=23 (18-39)[b]	Not specified	Within-subjects, repeated measures	Double-blind	Yes
Felisberti & Terry (2015) [33]	United Kingdom	18 (19% male)[a]	M=23[a]	Not specified	Within-subjects, repeated measures	Single blind[b]	No
Honan et al. (2018) [29]	Australia	64 (50% male)	M=23.6 (18-34)	Not specified	Between-subjects, independent groups	Single blind[b]	Yes
Kamboj et al. (2013) [40]	United Kingdom	48 (50% male)	M=23.6 (18-35)	Not specified	Between-subjects, independent groups	Double-blind	Yes
Kano et al. (2003) [28]	Japan	15 (100% male)	M=25.9 (22-43)	Not specified	Within-subjects, repeated measures	Single-blind[b]	No
Khouja et al. (2019): Study 1 [36]	United Kingdom	108 (50% male)	M=21 (128-39)	100% Japanese	Between-subjects, independent groups	Double-blind	Yes
Khouja et al. (2019): Study 2 [36]	United Kingdom	189 (49% male)	M=22 (18-39)	Not specified	Between-subjects, independent groups	Double-blind	Yes
Nagar et al. (2021): Study 1 [37]	Israel	71 (40.8% male)	M=24.3	Not specified	Between-subjects, Independent groups	Double-blind	No
Nagar et al. (2021): Study 2 [37]	Israel	21 (28.6% male)	M=24	Not specified	Within-subjects, repeated measures	Single-Blind[b]	No
Walter et al. (2011) [27]	Germany	102 (22% male)	M=21.7	Not specified	Between-subjects, repeated measures	Double-blind	Yes

Note. [a]Sample demographics are reported for the original sample collected, not for the final sample used in analyses
[b]Only the participants were blind to beverage assignment

Table 2: Alcohol Administration Procedures and Emotion Recognition Tasks

Reference	Alcohol conditions (dose in g/kg)	Alcohol Used (% by volume)	Time interval for drink consumption (min)	Interval between alcohol administration and ER Task(s) (min)	ER Task(s)	ER Outcome(s)	Emotions Measured
Attwood et al (2009)a [24]	Alcohol Condition A (0.2) Alcohol Condition B (0.4) Placebo Condition (0.0, tonic water)	Vodka (37.5)	20	Not specified	2AFC: neutral-full emotional exemplar	Detection threshold	Happiness Sadness Anger
Attwood et al. (2009)b [32]	Alcohol-told alcohol (0.4) Alcohol-told placebo (0.4) Placebo-told alcohol (0.0, tonic water) Placebo-told placebo (0.0, tonic water)	Vodka (37.5)	20	Not specified	2AFC with two conditions: angry-happy, angry-disgust	Balance point	Happiness Anger Disgust
Craig et al. (2009) [25]	Alcohol-told alcohol (0.4) Alcohol-told placebo (0.4) Placebo-told alcohol (0.0, tonic water) Placebo-told placebo (0.0, tonic water)	Vodka (37.5)	15	Not specified	2AFC: neutral-full emotional exemplar	Detection threshold	Happiness Sadness Anger
Dolder et al. (2017) [15]	Alcohol Condition (0.25-0.3)[a] Placebo Condition (0.0, non-alcoholic beer)	Beer (4.8)	15	15	FERT: neutral-full emotional exemplar	Detection threshold	Happiness Sadness Anger Disgust Fear Surprise
Eastwood et al. (2020) [39]	Alcohol Condition (0.4) Placebo Condition (0.0, tonic water)	Vodka (37.5)	10	10	6AFC: ambiguous-full emotional exemplar 2AFC with two conditions: happy-angry, happy-sad	Response sensitivity; Response bias; Balance point	Happiness Sadness Anger Disgust Fear Surprise

Felisberti & Terry (2015) [33]	Alcohol Condition A (0.2 for males, 0.17 for females) Alcohol Condition B (0.6 for males, 0.52 for females) Placebo Condition (0.0, tonic water)	Vodka (37.5)	15	20	Two 6AFC tasks modified for image duration (microexpressions, longer-expressions): neutral-full emotional exemplar	Accuracy scores; Reaction times	Happiness Sadness Anger Disgust Fear Contempt
Honan et al. (2018) [29]	Alcohol Condition (0.8)[b] Placebo Condition (0.0, soda water)	Not specified	10	Not specified	ERT: neutral-full emotional exemplar	Accuracy scores	Happiness Sadness Anger Disgust Fear Surprise
Kamboj et al. (2013) [40]	Alcohol Condition A (0.4) Alcohol Condition B (0.8) Placebo Condition (0.0, tonic water)	Not specified (90%)	30	10	DEER-T: neutral-full emotional exemplar	Accuracy scores; Reaction times; False alarms; Neutral response errors; Pr; Br	Happiness Sadness Anger Disgust Fear
Kano et al. (2003) [28]	Alcohol Condition A (0.14) Alcohol Condition B (0.28) Alcohol Condition C (0.56) Control 7Condition (0.0, orange juice)	Scotch whiskey (43%)	10*	30	2AFC: neutral-full emotional exemplar	Reaction times; Error ratios	Happiness Sadness Anger Surprise
Khouja et al. (2019) Study 1 [36]	Alcohol Condition (0.4) Placebo Condition (0.0, tonic water)	Vodka (not specified)	10	10	6AFC: ambiguous-full emotional exemplar	Total hits (accuracy)[c]; False alarms	Happiness Sadness Anger Disgust Fear Surprise
Khouja et al. (2019) Study 2 [36]	Alcohol Condition (0.4) Placebo Condition (0.0, tonic water)	Vodka (not specified)	10	10	6AFC: ambiguous-full emotional exemplar	Total hits (accuracy)[c]; False alarms; Balance point	Happiness Sadness Anger Disgust Fear

					2AFC: happy-angry		Surprise
Nagar et al. (2021) Study 1 [37]	Alcohol Condition A (0.3)[b] Alcohol Condition B (0.6)[b] Alcohol Condition C (0.9)[b] Placebo Condition (0.0, water)	Vodka (50%)	10	20	EFERT: neutral-full emotional exemplar	Accuracy scores	Happiness Sadness Anger Fear
Nagar et al. (2021) Study 2 [37]	Alcohol Condition A (0.3)[b] Alcohol Condition B (0.6)[b] Alcohol Condition C (0.9)[b] Placebo Condition (0.0, water)	Vodka (50%)	10	20	EFERT: neutral-full emotional exemplar	Accuracy scores	Happiness Sadness Anger Fear
Walter et al. (2011) [27]	Alcohol Condition (0.4) Placebo Condition (0.0, non-alcoholic sparkling wine)	Sparkling wine (not specified)	Not specified	10	Dynamic ERT: neutral-full emotional exemplar	Accuracy scores; Reaction times	Happiness Sadness Anger Disgust Fear Surprise

Note. ER = Emotion recognition; 2AFC=Two-Alternative Forced Choice; FERT=Facial Expression Recognition Test; 6AFC=Six-Alternative Forced Choice; ERT=Emotion Recognition Task; DEER-T=Dynamic Emotion Expression Recognition Task; EFERT=Emotional Facial Expression Recognition Task; Pr=measure of response sensitivity; Br=measure of response bias

[a]dosage is calculated based on sex and body weight to achieve a target BAC of 0.4 g/L

[b]dosages were reported as target BrAC values in the original paper and were converted to g/kg to align with reporting in the other papers

[e]Incorrect responses were removed to obtain the total number of correct emotion identifications, score used to capture accuracy

Table 3: Significant results for alcohol's effects on emotion recognition outcomes

Reference	Significant main findings regarding alcohol's effects on emotion recognition	Additional significant findings regarding moderating variables	Additional significant findings regarding emotion recognition biases
Attwood et al (2009)a [24]		Significant alcohol x participant sex interaction for sad expressions (F[2, 74]=3.95, p=0.024); males, compared with females, showed significantly higher thresholds for sad recognition. Post-hoc tests indicated that participants differed only at a moderate dose of alcohol (0.4 g/kg) (p=0.005), not among the placebo or lower-alcohol (0.2 g/kg) beverages (p>0.11).	

Attwood et al. (2009)b [32]			Males had significantly higher balance points (M=54.2, SD=7.3) compared to females (M=48.5, SD=8.9) in the angry-disgust task (F[1, 77]=9.71, p=0.003), indicating a bias among males to categorize disgusted expressions as angry. Significant emotion x target sex x drink interaction (F[1, 71]=5.52, p=0.022). Post-hoc tests revealed a significant target sex x drink interaction in the angry-disgusted task (F[1, 77]=9.14, p=0.003). Further analyses revealed a significant effect of alcohol for male (p=0.017) stimulus faces only.
Craig et al. (2009) [25]	Significantly higher thresholds for sad recognition in the alcohol (M=0.14, SD=0.02) compared with placebo (M=0.12, SD=0.02) condition (t(95)=6.20, p=0.015).	Males showed significantly higher threshold values (M=0.14, SD=0.02) than females (M=0.13, SD=0.02) for sad expressions independent of drink condition (t(95)=6.16, P=0.015). Males showed significantly higher threshold values (M=0.12, SD=0.02) than females (M=0.11, SD=0.02) for angry expressions independent of drink condition (t(95)=5.22, p=0.024). Significant three-way interaction of expectancy x target sex x target emotion [F(2,88)=3.16, p=0.047]. Post-hoc tests indicate lower thresholds for male stimulus faces (M=0.11, SD=0.02) compared with female stimulus faces (M=0.12, SD=0.03) in the placebo-expectancy condition only (t(48)=2.24, p=0.029).	
Dolder et al. (2017) [15]	Significantly lower thresholds for happy recognition in the alcohol compared to placebo (t(1,58)=2.73, p<0.01).		

Eastwood et al. (2020) [39]	Significant main effect of drink for response bias of happy recognition (F[1,83]=5.92, p=0.017, η2=0.67) indicating a reduced bias towards happy expressions following alcohol consumption compared with placebo. Significant, modest main effect of drink for response sensitivity of sad recognition (F[1, 83]=6.51, p=0.013, η2=0.73) indicating reduced sensitivity towards sad expressions following alcohol consumption compared with placebo. Significant, modest main effect of drink for response sensitivity of fear recognition (F[1, 83]=4.62, p=0.034, η2=0.053) indicating reduced sensitivity towards fearful expressions following alcohol consumption compared with placebo.		
Felisberti & Terry (2015) [33]	**Microexpressions:** Significantly greater accuracy scores for disgust recognition following a higher dose (0.6 g/kg for males, 0.52 g/kg for females) of alcohol compared with placebo (t(17)=-2.70, p=0.015, d=0.65), which was significantly greater than accuracy scores at a lower dose (0. 2 for males, 0.17 for females) of alcohol (t(17)=3.40, p=0.003, d=0.81). Significantly greater accuracy scores for contempt recognition at a higher dose (0.6 g/kg for males, 0.52 g/kg for females) of alcohol compared with placebo (t(17)=-2.15, p=0.045, Cohen's d=0.51), which was significantly greater than accuracy scores at a lower dose (0.2 for males, 0.17		

	for females) of alcohol (t(17)=2.38, p=0.03, d=0.61). **Longer expressions:** Significantly greater accuracy scores for disgust recognition at a higher dose (0.6 g/kg for males, 0.52 g/kg for females) of alcohol compared with placebo (t(17)=-3.12, p=0.006, d=0.76), which were not significantly different from a lower dose (0.2 g/kg for males, 0.17 g/kg for females) of alcohol (p>0.05). Significantly greater accuracy scores for contempt recognition at a higher dose (0.6 g/kg for males, 0.52 g/kg for females) of alcohol compared with placebo (t(17)=-3.10, p=0.007, d=0.71), which were not significantly different from a lower dose (0.2 g/kg for males, 0.17 g/kg for females) of alcohol (p>0.05).		
Honan et al. (2018) [29]	Alcohol participants were significantly less accurate in identifying sad expressions compared with placebo participants (Cohen's d=1.56) Alcohol participants were significantly less accurate in identifying fearful expressions compared with placebo participants (Cohen's d=1.21)		
Kamboj et al. (2013) [40]	Significant difference between drinking conditions for neutral-response errors for sad expressions (F(2,45)=3.828, p=0.029). Post-hoc tests reveal a significant difference existed only between the lower alcohol condition (0.4 g/kg) compared with the higher alcohol condition (0.8 g/kg) (p=0.025).	Females showed faster reaction times compared with males regardless of drink condition (F(1,42)=9.02, p=0.004).	
Kano et al. (2003) [28]	Significant difference between the levels of alcohol in reaction times for happy		

	recognition (F[3, 55] 1⁄4 4.1, p < 0.01). Post-hoc tests revealed a significant difference in reaction times existed only between a lower dose (0.14 g/kg) and a higher dose (0.56 g/kg) of alcohol (p<0.001). The higher dose of alcohol produced significantly faster reaction times than the lower dose of alcohol.		
Khouja et al. (2019) Study 1 [36]	Significantly fewer false alarms for happy expressions in the alcohol (M=9.1, SD=7.6) compared to the placebo (M=13.1, SD=9.4) condition (t[10]=-2.42, p=0.17, d=-.47) Significantly more false alarms for angry expressions in the alcohol (M=4.6, SD=4.1) compared to the placebo (M=3, SD=3.1) condition (t[94.6]=2.26, p=0.024, d=0.44).		
Khouja et al. (2019) Study 2 [36]			
Nagar et al. (2021) Study 1 [37]	Except for sadness, all analyses were significant (anger, F[3, 65]=2.81, p=0.046, partial η2=0.115; happiness, F[3, 6])=4.38, p=0.007, partial η2=0.168; fear, F[3, 65]=3.37, p=0.024, partial η2=0.135; sadness F[3, 65]=0.897, p=0.448, partial η2=0.040), revealing that alcohol level weakened the ability to correctly identify emotions. Statistical significance was reached at a BAC level of 0.09 compared with placebo only for happiness and fear (p’s<0.05).		
Nagar et al. (2021) Study 2 [37]		Single beverage administration diminished the ability to correctly identify emotions when compared with cumulative administration in BAC 0.03 (t(29.4)=2.75, p=0.010); 0.06 (t(43)=5.27, p<0.001); and 0.09 (t(12.1)=4.18, p=0.001). Post hoc ANOVAs revealed significant differences	

		in recognition of fear across all BACs (0.03, F[1, 45]=25.90, $p < 0.001$, partial $\eta2=0.37$; 0.06, F[1, 43]=21.24, $p < 0.001$, partial $\eta2=0.33$; and 0.09, F[1, 34]=41.62, $p < 0.001$, partial $\eta2=0.55$), indicating single-dose administration led to worse recognition of fear (0.03%BAC, M=57.0, SE=4.4; 0.06%BAC, M=58.3, SE=4.9; and 0.09%BAC, M=42.4, SE=5.5) as compared with cumulative administration (0.03%BAC, M=86.3, SE=3.7; 0.06%BAC, M=87.7, SE=4.0; 0.09%BAC, M=85.3, SE=3.7). Analyses also revealed worse recognition of anger in single (0.06%BAC, M=48.2, SE=5.2; 0.09%BAC, M=42.4, SE=7.6) vs. cumulative (0.06%BAC, M=64.8, SE=4.2; 0.09%BAC, M=60.0, SE=5.0) alcohol administration. The effect was significant in moderate alcohol level (F[1, 43]=6.24, p=0.016, partial $\eta2=0.13$). Analyses revealed worse happiness recognition in single (M=71.2, SE=4.1) versus cumulative (M=96.0, SE=2.7) alcohol administration in high alcohol level (0.09, F[1, 34]=25.26, $p<0.001$, partial $\eta2=0.43$).	
Walter et al. (2011) [27]		Participants who expected alcohol effects significantly detected more correct happy expressions than participants who did not expect alcohol effects (F[1, 94]=5.77, p=0.018, $\eta2=0.058$). Participants who expected alcohol effects significantly judged more expressions as happy than participants who did not expect alcohol effects (F[1, 94]=9.03,, p=0.003, $\eta^2=0.09$).	

Supplementary Scale 1. The modified adapted Quality Assessment Tool for Quantitative Studies (QATQS)

Selection A – Selection Bias (paper level)

Q1. Are the individuals selected to participate in the study likely to be representative of the target population?

1. Very likely
2. Somewhat likely
3. Not likely (selected group of users e.g., volunteers)
4. Can't tell (no information provided)
5. Not applicable (using an existing database and authors refer to design article)

Q2. What percentage of selected individuals agreed to participate?

1. 80 - 100% agreement
2. 60 – 79% agreement
3. less than 60% agreement
4. Can't tell
5. Not applicable

Rating selection bias:
Strong: Q1 is 1 and Q2 is 1.
Moderate: Q1 is 1 or 2 and Q2 is 1 or 2. Q1 is 1 or 2 and Q2 is 4. Q1 is 5 and Q2 is 1 or 2.
Weak: Q1 is 3. Q2 is 3. Q1 is 4. Q2 is 4.
No rating: Q1 is 5 and Q2 is 5.

Section B – Study Design (paper level)

Q3. The study design is:

1. Experimental
   - Individual-randomized
   - Group-randomized
   - Non-randomized
2. Observational
   - Cross-sectional
   - Longitudinal (also natural experiment or pre-post tests)
   - Case-control
3. Any other method or did not state method (i.e., pre-post test without control group)

Q4. Was the study described as randomized?

1. Yes – proceed
2. No – go to question 9

Q5. Was the method of randomization described?

1. Yes
2. No

Q6. Was the method appropriate?

1. Yes
2. No

Q7. Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?

1. Yes
2. No
3. Can't tell

Q8. Were the study participants aware of the research question?

1. Yes
2. No
3. Can’t tell

Rating study design:
Strong: Q3 is 1.
Moderate: Q3 is 2.
Weak: Q3 is 3.

Rating blinding:
Strong: Q4 and Q5 are 1.
Moderate: Q4 is 1. Q5 is 1. Q7 and Q8 are 3.
Weak: Q4 or Q5 are 2.

Section C – confounding

Q9. Were analyses appropriately adjusted and reported for confounders?
1. For most confounders (meaning at least age and sex and/or education and/or SES)
2. For some confounders (meaning at least two of the following: age, sex, education or SES)
3. No or can’t tell

Rating confounding:
Strong: Q8 is 1.
Moderate: Q8 is 2.
Weak: Q8 is 3.

Section D – Representativeness (withdrawals and drop-outs) (paper level)

Q10. Were withdrawals and drop-outs reported in terms of numbers and reasons per group?
1. Numbers and reasons provided
2. Numbers but no reasons provided
3. Can’t tell (if longitudinal data)
4. Not applicable (i.e., cross-sectional data, using an existing database and authors refer to design article)

If Q10 is 1 or 2, proceed to Q11. Otherwise, proceed to Q12.

Rating Representativeness:
Strong: Q10 is 1.
Moderate: Q10 is 2 or 4
Weak: Q10 is 3

Section E – Reporting

Q12. Are the hypothesis/aim/objective of the study clearly described? (paper level)
1. Yes
2. No

Q13. Were inclusion/exclusion criteria specified and number of exclusions reported? (paper level)
1. Criteria and number of exclusions reported
2. Criteria or number of exclusions not reported
3. Criteria and number not reported

Rating Reporting:
Strong: Q12 is 1 and Q13 is 1.
Moderate: Q12 is 1, Q13 is 2.
Weak: Q12 is 1 or 2, Q13 is 3.

Overall rating:
6 ratings

Strong: At least three strong
Moderate: Fewer than three strong
Weak: More than one weak

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