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Music and substance use: A meta-analytic review

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ABSTRACT

While previous research has documented a relation between music and substance use among consumers, to date, there are no meta-analytic reviews of the literature, making our meta-analysis the first in this area. Results from 31 studies, yielding a total of 330,652, indicated that music had a significant effect on substance use, with both music format and genre being significant contributors. The effect of music on substance use also varied by substance type. In addition, participant biological sex and location of data collection were found to moderate the effect of music on substance use. Theoretical implications are discussed along with directions for future research.

KEYWORDS

Music media; substance use; meta-analysis

It has been speculated that music is a key characteristic of youth culture (North, Hargreaves, & O'Neill, 2000), playing an important role in the development of social beliefs and having the potential to influence both attitudes and behaviors related to substance use (Peterson, Wingood, DiClemente, Harrington, & Davies, 2007; Pettigrew, Henriques, & Farrier, 2017; Rigg & Estreet, 2018; Wingood et al., 2003). Music preferences have been related to positive beliefs about and an increased likelihood of substance use (Christenson, Roberts, & Bjork, 2012; Cranwell, Britton, & Bains, 2017; Diamond, Bermudez, & Schensul, 2006; Furr-Holden, Voas, Kelley-Baker, & Miller, 2006; Herd, 2008; Lim, Hellard, Hocking, & Aitken, 2008; Lim, Hellard, Hocking, Spelman, & Aitken, 2010; Markert, 2001; Mulder et al., 2009; Primack, Douglas, & Kraemer, 2010; Rigg & Estreet, 2018; Russell, Regnier-Denois, Chapoton, & Buhrau, 2017; Slater & Henry, 2013; Wright & DeKemper, 2016). This is important considering that music emerges as a preferred form of popular media during early adolescence (Roberts, Foehr, & Rideout, 2005) and continues through emerging adulthood (Behance, 2013). In fact, the most frequent consumers of music are adolescents (Roberts et al., 2005; Russell et al., 2017; van Oosten, Peter, & Valkenburg, 2015), and it has been estimated that adolescents and young

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adults listen to music between two and four hours each day (Agbo-Quaye & Robertson, 2010; Primack, Nuzzo, Rice, & Sargent, 2012).

Considering the interrelated nature of risky behaviors among young media consumers (Vogel, van de Looij-Jansen, Mieloo, Burdorf, & de Waart, 2012), the impact of music content may be of concern. For example, adolescent substance use is correlated with criminal behavior, unprotected sexual intercourse, progression toward illicit drug use, and substance dependence later in life (Cranwell et al., 2017). These risky behaviors can result in lower grades, higher rebelliousness, and higher sensation seeking (Miller, Kelley, Midgett, & Parent, 2016), although a bidirectional relationship may also explain this phenomenon. In addition, research has found that viewing music videos may be related to less-aversive attitudes toward driving under the influence of alcohol, as well as more intentions to do so in the future (ter Bogt & Harakeh, 2012). Specific music genre preferences, such as hip-hop and rap, have also been associated with an increase in 3,4-methylenedioxymethamphetamine (MDMA or ecstasy) use among consumers (Rigg & Estreet, 2018).

Ultimately, substance use has numerous negative effects on behaviors and attitudes and can increase the risk for negative health outcomes. The consumption of alcohol is related to liver and cardiovascular diseases, as well as cancer (Cranwell et al., 2017). There also exist racial disparities in the negative effects of substance use. For example, African Americans are more likely to die from alcohol-related mental and behavioral disorders, alcoholic cardiomyopathy, and oral cavity-pharynx cancer, and Hispanics are more likely to experience cirrhosis of the liver and alcohol-related automobile accidents (Polednak, 2008; Yoon, Yi, & Thomson, 2011). Substance use has also been associated with increased levels of depression, anxiety, and panic attacks as well as seizures, arrhythmia, and hyperthermia (Badon et al., 2002; Giorgi et al., 2006; Lamers et al., 2003; Soar, Turner, & Parrott, 2001).

Risk factors

It may be that younger consumers engage more with music due to their focus on identity development, exploration, and role transitions during this time (Arnett, 2000; Kam et al., 2014; Lonsdale & North, 2011; Miller et al., 2016; Roe, 1999; ter Bogt & Soitos, 2007; Thomas, 2016). Identity formation begins during adolescence (Erikson, 1959/1980) and continues into emerging adulthood (Grotevant, 1998; Waterman, 1999), involving both exploration and self-focus (Arnett, 2004). Previous research has suggested that music is important for identity formation during the adolescent years (Gardikiotis & Baltzis, 2012; North et al., 2000; Tarrant, North, &

Hargreaves, 2002; Zillmann & Gan, 1997) and continues to play a role in social interactions for evaluative functions and group identification during emerging adulthood (Rentfrow & Gosling, 2007; Tekman & Hortaçsu, 2002). In fact, ter Bogt, Mulder, Raaijmakers, and Gabhainn (2011) identified four main functions of music for young consumers, including mood enhancement, coping, personal identity formation, and social identity.

Younger consumers may also have music preferences based on race and biological sex (Bayles, 2005; Behance, 2013; Gaille, 2015; Newman, 2009; Ross, 2006; MusicWatch, 2015; The Numbers Guy, 2005). For example, it was previously estimated that White non-Hispanic youth were the main consumers of rap music, with estimates ranging from 60% to 80% (Bayles, 2005; The Numbers Guy, 2005). More recent estimates, however, report that 29% of the hip-hop radio audiences are White non-Hispanic, Asian, or biracial (Gaille, 2015). MusicWatch (2015), on the other hand, classified consumers as either African American or not African American and reported that the majority of music consumers are not African American, with estimates ranging from 83% to 91% depending on the method of music consumption (e.g., CD purchases, music streaming, paid music subscriptions). MusicWatch also classified rap/hip-hop as in the top three preferred music genres among consumers. In addition, it has been reported that women tend more to prefer country and pop music compared to men (Behance, 2013; Newman, 2009) and that men tend more to prefer rap music compared to women (Ross, 2006).

Generally, research examining substance use across the lifespan has found that substance use, particularly alcohol use, increases during emerging adulthood and then declines (Arnett, 2000; Chen & Jacobson, 2012). While some research has found that African American emerging adults were more likely to have used marijuana in comparison to other ethnic groups (Primack et al., 2010), other research has found that African American emerging adults are less likely to use alcohol and illegal drugs compared to White non-Hispanics (Godette, Headen, & Ford, 2006; Madison-Colmore, Ford, Cooke, & Ellis, 2003; McCabe et al., 2007; Myers, 2013; Stern & Wiens, 2009; Strycker, Duncan, & Pickering, 2003; Watt, 2008; Wright & DeKemper, 2016). Kam et al. (2014) found that Hispanic adolescents typically had risk factors associated with substance use, such as listening to rap or hip-hop music and having a lower socioeconomic status (SES). In addition, "purple drank" (i.e., codeine and promethazine mixed with soda) is predominately used by African American men, although individuals with lower SES are more likely to experiment with codeine use (Hart et al., 2014). Other research has also demonstrated differences in rates of marijuana and alcohol use based on participant race (Bergeson, Kelly, Fitch, & Mueller, 2001; Jinsook & McCarthy, 2006; Johnston, O'Malley, Bachman, & Schulenberg, 2006; Rodham, Hawton, Evans, & Weatherall, 2005; Wright & DeKemper, 2016).

Substance use references in music

Considering the increasing substance use references in popular music, the relationship between music content and substance use is not surprising. Today, thousands of songs are easily assessable that include references to substance use, including alcohol, tobacco, and other drugs (Russell et al., 2017). It has even been suggested that ethnically targeted marketing uses music as a mechanism to reach particular audiences, such as Brown and Williamson's music campaign promoting tobacco use by targeting young African American males (Castro 2004; Gardiner, 2004; Hafez & Ling, 2006; Sutton & Robinson, 2004). The number of songs containing substance use content has drastically increased over time (Christenson et al., 2012; Pettigrew et al., 2017). In 1988, only 12% of the Top 100 Billboard Songs included such content; this increased to 30% two decades later (Kam, Wang, & Harvey, 2014). Alcohol images exist in as much as 45% of popular music videos on YouTube, with tobacco imagery following at 22% (Cranwell et al., 2017; Smith, Aycock, Hook, Chen, & Rueger, 2017). Primack, Kraemer, Fine, and Dalton (2009) reported that music consumers are exposed to an average of 27 marijuana references daily. Furthermore, an analysis of ecstasy references in rap music found that 69 songs between 1996 and 2003 contained references to the drug (Diamond et al., 2006). MDMA references have also increased in hip-hop, rap, and pop music (Baker & Moore, 2012; Diamond et al., 2006).

The majority of substance use references in music are positive, rarely touching on the negative consequences of consumption (Cranwell et al., 2017; Kam et al., 2014; Pettigrew et al., 2017). Most of these songs glorify substance use, tobacco, and alcohol, linking use with positive images of success, wealth, glamour, partying, sexual activity, and socializing (Cranwell et al., 2017; Diamond et al., 2006; Pettigrew et al., 2017). For example, hip-hop artist Lil' Wayne wrote a song dedicated to the substance known popularly as *purple drank* but downplayed his own hospitalization for seizures connected to use of the substance (Hart, Agnich, Stogner, & Miller, 2014).

Substance use content varies by music genre. Several studies have shown that rap and hip-hop, rock, and dance/electronica listeners are especially likely to use substances because drugs are tied to the genres' cultures, which tend to be energetic (Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015). A study of Dutch adolescents found that pop and classical music were associated with less substance use. This same study reported that hardcore punk and techno, as well as reggae music, were associated with increased substance use (Mulder et al., 2009). Mulder et al. (2010) reported that adolescents who preferred pop and adult-oriented music were less likely to perceive that their peers were using drugs, whereas those who preferred hard rock were more likely to perceive that their peers were using drugs. Rap and hip-hop, especially, have been noted for extensive reference to and glamorization of substance use. In addition, greater exposure to rap and hip-hop has been related to increased substance use among consumers (Diamond et al., 2006; Herd, 2008; Markert, 2001; Miller, Kelley, Midgett, & Parent, 2016). Furthermore, substance use references in rap music increased from being included in 11% of songs in the early 1980s to inclusion in 69% of songs in the late 1990s (Herd, 2008). Rap and hip-hop music artists often overemphasize or exaggerate their own use of substances, which can be problematic for consumers who desire to model themselves after their favorite music artists (Inkster & Sule, 2015).

Rebellious music styles, such as various types of rock, also exhibit substance use references and are correlated with high substance use among consumers (Mulder et al., 2010; Oberle & Garcia, 2015). Previous studies have suggested that excessive substance use has been a theme in rock music that has steadily increased over time (Oksanen, 2012). At one point, preference for electronic dance music was the best indicator of substance use (ter Bogt & Harakeh, 2012). However, a study conducted throughout several European countries concluded that preference for pop and high-brow was negatively associated with substance use, while preference for dance music was associated positively with substance use (ter Bogt et al, 2012). Furthermore, music festivals have offered researchers an opportunity to examine the correlation between drug use and music preference, finding that participants who preferred dance/house or rap music were more likely to have used illicit drugs within the past month, while those who preferred pop or alternative music were less likely to have used illicit drugs in the past month (Lim et al., 2008). A follow-up study found that those who preferred rock/pop, dance, and metal music genres were more likely to have used substances in the past month compared to those who preferred rap music (Lim et al., 2010). Even so, those attending music festivals were more likely to use illicit drugs compared to those in the general public (Lim et al., 2008).

Theoretical perspective

According to the uses and gratifications paradigm (Katz, Blumler, & Gurevitch, 1973; Rubin, 2009), consumers with prior substance use histories or those who are interested in learning about substance use effects seek out music that contains substance use references for reasons such as normalization and acceptance of their own behavior, strengthening friendships and peer relationships, or conforming to a subgroup or subculture (Bleakley, Hennessy, Fishbein, & Jordan, 2008). Repeated exposure to such music may blur the line between reality and fantasy for consumers (Russell et al., 2017), similar to the cultivation framework, which contends that the more people live in the media world, the more likely they are to believe that what is portrayed is real (Cohen & Weimann, 2000; Gerbner, Gross, Morgan, & Signorielli, 1994). In addition, musicians may create a false reality about the potential for negative consequences that are associated with substance use (Beullens, Roe, & Van den Bulck, 2012) because negative consequences are rarely, if ever, portrayed in music. Portraying substance use in this way could lead to consumers making decisions, adopting attitudes, and behaving similarly to the music content to which they are exposed, especially if they view the music artist as similar to themselves and respected (Brown, 2002; Cranwell et al., 2017; Diamond et al., 2006; Knobloch-Westerwick, Musto, & Shaw, 2008; Kohn, 1969; 1983; Rigg & Estreet, 2018; Slater & Henry, 2013; Smith et al., 2017). Furthermore, many music genres are connected with specific subcultures, which may promote or encourage substance use (Hart et al., 2014; Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015). Viewing music then as a “super peer” (Ward et al., 2011) may increase the likelihood of young consumers engaging in substance use as research has repeatedly demonstrated that youth are influenced by peer substance use (Bauman & Ennett, 1994; Borsari & Carey, 2001; Vidourek, King, & Montgomery, 2017). In essence, then, exposure to substance use references in music is expected to alter consumers’ attitudes related to substance use, which may then influence their actual behaviors.

The current study

The majority of previous research, utilizing various research designs, has found an association between music and substance use among consumers. To date, there have been no meta-analytic reviews on the topic. No meta-analytic reviews of general media effects on substance use have been conducted, much less a meta-analytic review focusing on music. A meta-analytic review that quantitatively combines data from previous research in this area to estimate the effect size between music and substance use, investigate potential moderators between music and substance use, as well as examine variations in the outcomes of previous research is well overdue.

Accordingly, we conducted a meta-analysis to provide a statistical review of findings in this area. We focused on music that previous research has documented as containing increased levels of substance use references (e.g., electronica, high-brow, reggae, rock, urban, Top Charts, pop) (Baker & Moore, 2012; Diamond et al., 2006; Hart et al., 2014; Herd, 2008; Inkster & Sule, 2015; Lim et al., 2008; 2010; Mulder et al., 2009; 2010; Oberle & Garcia, 2015; Oksanen, 2012; ter Bogt & Harakeh, 2012; Wright & DeKemper, 2016). We also examined the different types of substances that have been examined in previous research (e.g., alcohol, tobacco, marijuana, crack cocaine, sedatives, prescription drugs without a prescription, purple drank, club drugs) (e.g., Barrett, Gross, Garand, & Pihl, 2005; Beullens et al., 2012; Beullens & Van den Bulck, 2014; Chen, Miller, Grube, & Waiters, 2006; Hart et al., 2014; Kam et al., 2014; Lim et al., 2008; Mulder et al., 2009; Oberle & Garcia, 2015; Palamar, Griffin-Tomas, & Ompad, 2015; Primack et al., 2009; 2010; Slater & Henry, 2013; Smith et al., 2017). In addition, previous research has not standardized the way music has been examined. While some studies have focused on music audio lyrics, others have examined music videos, music genre preferences, night clubs, and the influence of music performance venues (e.g., Kam et al., 2014; Slater & Hayes, 2010; Pedersen, 2009; Palamar et al., 2015; Van Den Bulck & Beullens, 2005). We included an examination of these music formats and examined potential moderators.

Method

Literature search procedures and selection of studies

A systematic computer-based search was conducted through MedLine, PsycINFO, Emerald Insight, CINAHL Plus with Full Text, and Communications and Mass Media in September and October 2017 as well as June 2018 to search for relevant articles. There were no restrictions on geography or culture in which studies were conducted. However, the period of publication was limited to 2000–2018. The following search terms were used: "adolescent or youth," "emerging adult," "substance use," "drug use," "substance abuse," "drug abuse," and "music." For a study to be included it must have meet the following criteria: (1) Each study must measure the influence of music on substance use (e.g., marijuana, alcohol). Other forms of media were not included in this study. (2) Each study must present statistical outcomes or data that could be used to determine the effect size *r*. (3) Participants in the study must be classified as adolescents (e.g., age 13–17) and/or emerging adults (e.g., 18–25). Longitudinal studies that began during adolescence and extended into emerging adulthood could be included. (4) Each study must have been written in or translated into English to be included in this study.

The initial search returned approximately 232 hits, the majority of which (201) did not meet the inclusion criteria. Employing the inclusion criteria, the final search obtained 31 published article, with total participants $n = 330,652$. Two published articles included two studies within the article (i.e., Kam et al., 2014; Wright & DeKemper, 2016). In addition, several studies examined multiple music formats, multiple music genres, multiple substance types, multiple age groups, or multiple participant races. Subsequently, these were coded separately, yielding a total of 136 studies included in analyses. Information regarding articles selected can be found in Table 1.

Coding of studies

Each study was coded for substance use. Type of substance use was coded as alcohol, tobacco, marijuana, crack cocaine, sedatives, prescription drugs without a prescription, or purple drank. Use of club drugs was also coded and included such drugs as ecstasy, MDMA, GHB, ketamine, amphetamines, methamphetamines, and hallucinogens (see Chen et al., 2006). Salvia, stimulants, roofies, tranquilizers, bath salts, cocaine, and synthetic cannabinoids were also coded as club drugs (see National Institute on Drug Abuse, 2014; Palamar, Palamar, Le, & Cleland, 2018). A few studies used a summed score combining the use of tobacco, marijuana, and alcohol that could not be separated and were coded as "tobacco, marijuana, alcohol." Some studies examined multiple illicit drugs that could not be separated and were coded as "multiple illicit drugs."

The biological sex of each study sample was coded according to the percentage of male participants in the study. Age of participants was classified as adolescent (e.g., 13–17) or emerging adult (e.g., 18–25) based on either the age range of participants provided or the mean age of participants. Participant race was coded as either White non-Hispanic or racial minority group based on the majority of sample participants (>50%). One study (Oberle & Garcia, 2015) had a distribution of 50% participants who were White non-Hispanic and 50% participants from various racial minority groups. This study was coded as White non-Hispanic considering that the majority of research has included White non-Hispanic participants.

Music format was coded as audio, music videos, music preference, music performance venue, night clubs, or general music media. Music genre was coded as country music, electronica (dance, techno), high-brow (classical, jazz, blues, soul), reggae, rock (alternative, heavy metal, rock, punk), urban (R&B, rap, hip-hop), Top Charts, and pop music. However, many studies examined multiple genres in their study that could not be separated and were coded as "multiple genres." These studies included such genres as alternative, rap, and heavy metal. Some studies also did not specify the genre included in their study and were coded as "not specified." Each study

Table 1. Studies Included in Meta-analysis for Substance Use.

Article	*N*	*R*	*SE*	% male	Age	Race	Location	Format	Genre	Design	Substance type
Barrett et al. (2005)[a]	186	.04	.07	50	2	1	5	VEN	NS	CS	A
	186	.05	.07	50	2	1	5	VEN	NS	CS	M
	186	.31	.07	50	2	1	5	VEN	NS	CS	CD
Beullens et al. (2012)	426	.06	.05	66.4	2	1	4	V	NS	CS	A
Beullens & Van den Bulck (2014)	1,147	.34	.03	51.79	1	1	4	V	NS	L	T
Buttram et al. (2018)[a]	498	.97	.00	55	22	2	1	VEN	EL	CS	A
	498	.83	.01	55	2	2	1	VEN	EL	CS	CD
	498	.71	.02	55	2	2	1	VEN	EL	CS	P
Chen et al. (2006)[a]	1,056	.04	.03	43	2	2	1	P	C	CS	A
	1,056	.06	.03	43	2	2	1	P	C	CS	M
	1,056	.08	.03	43	2	2	1	P	C	CS	CD
	1,056	.07	.03	43	2	2	1	P	REG	CS	A
	1,056	.13	.03	43	2	2	1	P	REG	CS	M
	1,056	.06	.03	43	2	2	1	P	REG	CS	CD
	1,056	.08	.03	43	2	2	1	P	EL	CS	A
	1,056	.02	.03	43	2	2	1	P	EL	CS	M
	1,056	.12	.03	43	2	2	1	P	EL	CS	CD
	1,056	.02	.03	43	2	2	1	P	R	CS	A
	1,056	.03	.03	43	2	2	1	P	R	CS	M
	1,056	.04	.03	43	2	2	1	P	R	CS	CD
	1,056	.08	.03	43	2	2	1	P	U	CS	A
	1,056	.08	.03	43	2	2	1	P	U	CS	M
	1,056	.06	.03	43	2	2	1	P	U	CS	CD
Engels et al. (2012)	249	.99	.00	55	2	1	2	P	M	E	A
Hart et al. (2014)[a]	2,349	.35	.02	48	2	1	1	P	U	CS	PD
	2,349	.21	.02	48	2	1	1	P	R	CS	PD
	2,349	.01	.02	48	2	1	1	P	HB	CS	PD
Hesse & Tutenges (2012)[a]	1,787	.03	.02	56	2	1	8	VEN	R	CS	A
	1,787	.03	.02	56	2	1	8	VEN	R	CS	T
	1,787	.07	.02	56	2	1	8	VEN	R	CS	M
	1,787	.08	.02	56	2	1	8	VEN	R	CS	MI
	1,787	.05	.02	56	2	1	8	VEN	U	CS	A
	1,787	.12	.02	56	2	1	8	VEN	U	CS	T
	1,787	.12	.02	56	2	1	8	VEN	U	CS	M
	1,787	.08	.02	56	2	1	8	VEN	U	CS	MI
	1,787	.04	.02	56	2	1	8	VEN	HB	CS	A
	1,787	.05	.02	56	2	1	8	VEN	HB	CS	T
	1,787	.02	.02	56	2	1	8	VEN	HB	CS	M
	1,787	.05	.02	56	2	1	8	VEN	HB	CS	MI
	1,787	.00	.02	56	2	1	8	VEN	EL	CS	A
	1,787	.08	.02	56	2	1	8	VEN	EL	CS	T
	1,787	.08	.02	56	2	1	8	VEN	EL	CS	M
	1,787	.07	.02	56	2	1	8	VEN	EL	CS	MI
	1,787	.09	.02	56	2	1	8	VEN	P	CS	A
	1,787	.13	.02	56	2	1	8	VEN	P	CS	T
	1,787	.22	.02	56	2	1	8	VEN	P	CS	M
	1,787	.12	.02	56	2	1	8	VEN	P	CS	MI
Hughes et al. (2017)	4,117	.19	.01	55	2	1	3	VEN	NS	E	MI
Kam et al. (2014)[a]	253	.37	.06	56	1	2	1	A	NS	CS	A
	253	.24	.06	56	1	2	1	A	NS	CS	T
	253	.20	.06	56	1	2	1	A	NS	CS	M
	308	.34	.05	49	1	1	1	A	NS	CS	A
	308	.27	.05	49	1	1	1	A	NS	CS	T
	308	.25	.05	49	1	1	1	A	NS	CS	M
Lim et al. (2008)[a]	939	.13	.03	46	2	1	3	P	U	CS	M
	939	.16	.03	46	2	1	3	P	U	CS	CD
	939	.11	.03	46	2	1	3	P	EL	CS	M
	939	.33	.03	46	2	1	3	P	EL	CS	CD
	939	.07	.03	46	2	1	3	P	R	CS	M

(*continued*)

Table 1. Continued.

Article	*N*	*R*	*SE*	% male	Age	Race	Location	Format	Genre	Design	Substance type
	939	.17	.03	46	2	1	3	P	R	CS	CD
	939	.21	.03	46	2	1	3	P	P	CS	M
	939	.23	.03	46	2	1	3	P	P	CS	CD
Lim et al. (2010)	5,283	.02	.01	43	2	1	3	VEN	R	CS	MI
Miller et al. (2016)	60	.36	.12	37	22	1	1	A	M	CS	TMA
Miranda et al. (2012)[a]	429	.17	.05	47	1	2	5	A	NS	CS	TMA
	429	.17	.05	47	1	2	5	A	NS	CS	TMA
Mohr et al. (2017)	342	.06	.05	55	22	2	1	VEN	EL	CS	MI
Mulder et al. (2010)[a]	7,324	.28	.01	42	1	1	2	P	TC	CS	TMA
	7,324	.17	.01	42	1	1	2	P	HB	CS	TMA
	7,324	.25	.01	42	1	1	2	P	U	CS	TMA
	7,324	.17	.01	42	1	1	2	P	EL	CS	TMA
Mulder et al. (2009)[a]	7,324	.08	.01	42	1	1	2	P	TC	CS	T
	7,324	.03	.01	42	1	1	2	P	U	CS	T
	7,324	.13	.01	42	1	1	2	P	R	CS	T
	7,324	.13	.01	42	1	1	2	P	EL	CS	T
	7,324	.05	.01	42	1	1	2	P	REG	CS	T
	7,324	.07	.01	42	1	1	2	P	HB	CS	T
Oberle & Garcia (2015)[a]	335	.14	.05	23	2	2	1	P	P	CS	A
	335	.18	.05	23	2	2	1	P	P	CS	T
	335	.20	.05	23	2	2	1	P	P	CS	M
	335	.09	.05	23	2	2	1	P	C	CS	A
	335	.09	.05	23	2	2	1	P	C	CS	T
	335	.31	.05	23	2	2	1	P	C	CS	M
	335	.11	.05	23	2	2	1	P	U	CS	A
	335	.10	.05	23	2	2	1	P	U	CS	T
	335	.15	.05	23	2	2	1	P	U	CS	M
	335	.17	.05	23	2	2	1	P	EL	CS	A
	335	.06	.06	23	2	2	1	P	EL	CS	T
	335	.12	.05	23	2	2	1	P	EL	CS	M
	335	.10	.05	23	2	2	1	P	R	CS	A
	335	.07	.06	23	2	2	1	P	R	CS	T
	335	.14	.05	23	2	2	1	P	R	CS	M
	335	.03	.06	23	2	2	1	P	HB	CS	A
	335	.02	.06	23	2	2	1	P	HB	CS	T
	335	.12	.05	23	2	2	1	P	HB	CS	M
Palamar et al. (2015)[a]	7,373	.22	.01	48	2	1	1	VEN	EL	CS	M
	7,373	.29	.01	48	2	1	1	VEN	EL	CS	CD
	7,373	.32	.01	48	2	1	1	VEN	EL	CS	S
	7,373	.37	.01	48	2	1	1	VEN	EL	CS	CK
Pedersen (2009)	1,360	.38	.02	45	1	1	7	P	NS	L	M
Primack et al. (2010)	959	.16	.03	48	1	2	1	A	TC	CS	M
Primack et al. (2009)[a]	1,211	.25	.03	48	1	1	1	A	NS	CS	M
	1,211	.19	.03	48	1	1	1	A	NS	CS	A
Slater & Hayes (2010)	2,259	.23	.02	52	1	1	1	V	NS	L	T
Slater & Henry (2013)[a]	2,691	.15	.02	47	1	1	1	MM	M	L	T
	2,691	.12	.02	47	1	1	1	MM	M	L	M
Smith et al. (2017)[a]	4,196	.19	.02	53	1	1	1	V	NS	CS	A
	4,196	.14	.02	53	1	1	1	V	NS	CS	T
	4,196	.18	.02	53	1	1	1	A	NS	CS	A
	4,196	.17	.02	53	1	1	1	A	NS	CS	T
Stalgaitis et al. (2018)	5,153	.03		39	1	2	1	P	M	CS	T
ter Bogt et al. (2012)[a]	18,103	.21	.01	49	1	1	6	P	TC	CS	TMA
	18,103	.10	.01	49	1	1	6	P	R	CS	TMA
	18,103	.11	.01	49	1	1	6	P	U	CS	TMA
	18,103	.30	.01	49	1	1	6	P	EL	CS	TMA
	18,103	.17	.01	49	1	1	6	P	HB	CS	TMA
Van Den Bulck & Beullens (2005)	1,648	.17	.02	55	1	1	4	V	NS	L	A

(*continued*)

Table 1. Continued.

Article	*N*	*R*	*SE*	% male	Age	Race	Location	Format	Genre	Design	Substance type
Van Havere et al. (2011)[a]	775	.22	.03	62	2	1	4	P	EL	CS	M
	775	.32	.03	62	2	1	4	P	EL	CS	CD
	775	.20	.03	62	2	1	4	P	R	CS	CD
	775	.20	.03	62	2	1	4	VEN	R	CS	CD
	775	.14	.03	62	2	1	4	VEN	EL	CS	CD
	775	.11	.03	62	2	1	4	NC	EL	CS	CD
Vogel et al. (2012)[a]	944	.14	.03	37	2	1	2	A	NS	CS	T
	944	.14	.03	37	2	1	2	A	NS	CS	A
	944	.22	.03	37	2	1	2	A	NS	CS	M
	944	.05	.03	37	2	1	2	A	NS	CS	MI
	944	.14	.03	37	2	1	2	VEN	NS	CS	T
	944	.45	.03	37	2	1	2	VEN	NS	CS	A
	944	.14	.03	37	2	1	2	VEN	NS	CS	M
	944	.15	.03	37	2	1	2	VEN	NS	CS	MI
Wright & DeKemper (2016)[a]	425	.20	.05	31	2	1	1	A	M	CS	TMA
	425	.15	.05	31	2	1	1	V	M	CS	TMA
Total *N*	330,652										

Note. Age is coded as 1 = adolescents; 2 = emerging adults. Race is coded as 1 = White non-Hispanic participants; 2 = minority group participants. Location is coded as 1 = United States; 2 = Netherlands; 3 = Australia; 4 = Belgium; 5 = Canada; 6 = Europe; 7 = Norway; 8 = Denmark. Format is coded as A = audio music; MM = general music media; NC = night club; P = preference; V = music videos; VEN = performance venue. Genre is coded as C = country; EL = electronic; HB = high-brow; M = multiple genres; NS = not specified; P = pop; R = rock; REG = reggae; TC = top charts; U = urban. Design is coded as CR = cross-sectional; E = experimental; L = longitudinal. Substance type is coded as A = alcohol; CD = club drugs; CK = crack; M = marijuana; MI = multiple illicit drugs; P = prescription drugs without a prescription; PD = purple drank; S = sedatives; T = tobacco; TMA = summed score combining use of tobacco, marijuana, and alcohol.
[a]Included multiple studies or variables of interest, each coded separately for meta-analysis.

was also coded for the research design that best described the study (e.g., longitudinal, cross-sectional, experimental), the location of data collection, and publication year.

Estimating effect size

In the present analysis, controlled effect sizes (i.e., standardized regression weights) were examined. The effect size *r* was used in this analysis both due to the inclusion of longitudinal and correlational effect sizes in the analysis and because *r* is a straightforward effect size and easy to interpret. In addition, considering that confounding variables may exist, Savage and Yancey (2008) argued that controlled effect sizes are the preferred inclusion for meta-analyses. While many studies reported regression weights or correlational results, the results of other studies had to be converted to *r* prior to analysis (e.g., odds ratio, *f*, *t*, *M*, and *SD*).

Some studies reported more than one effect size that was relevant to a single underlying construct (i.e., multiple measures of substance use behavior). When this occurred, they were aggregated for a single average effect size that was included in analysis to maintain the assumption of independent effects as recommended by Borenstein, Hedges, Higgins, and Rothstein

(2009) (see Chapter 24). A few studies reported nonsignificant findings. When this occurred, in line with Levine (2013), effect sizes were included in the meta-analysis. According to Levine (2013), reduced statistical power is a major cause of nonsignificant results, and nonsignificant results should be included, where provided, in meta-analyses to provide a stronger and more robust test than the original study due to the increased power provided by the meta-analysis. Some studies also included music genres that are not of interest in this meta-analysis (e.g., religious, world). When that occurred, results for those genres were omitted. Finally, some studies examined multiple music formats (i.e., audio and videos) on the outcome measure (i.e., substance use behavior). When this occurred, each result was entered separately in the meta-analysis.

Analyses

The Comprehensive Meta-Analysis (CMA) software program was used to conduct the meta-analysis. We used a random-effects model weighted by variance, more specifically the DerSimonian and Laird method (see Borenstein et al., 2009, Chapter 12) to estimate effect sizes, rather than a fixed-effects model, due to estimation limitations of fixed-effects models (Cafri, Kromrey, & Brannick, 2010; Hunter & Schmidt, 2004). In addition, due to the nature of the predictor and outcome variable in this study, positive effects represented associations with aspects of music and substance use. Publication bias and moderator variables were assessed. All results discussed in the following were coded such that positive effect sizes represent associations with negative outcomes.

Results

Overall effect

Results for substance use can be found in Table 2. The overall effect size estimate (r) of music on substance use was .19 ($N = 330{,}652$, $k = 136$, $Z = 14.32$, $p < .001$, 95% CI [.16, .21]). Most studies showed a positive relationship between music and substance use.

Single study sensitivity and publication bias

The disproportionate influence of single studies on the overall effects for substance use was examined by reconducting the meta-analysis with a different study removed each time. The r in these estimates ranged from .16 to .21 for substance use. The fact that these estimates were not substantially

Table 2. Meta-analysis Results for Substance Use.

	k	*r*	CI_{LL}	CI_{UL}	*z*	*p*
Overall effect	136	.19	.16	.21	14.32	<.001
Substance type						
Tobacco	26	.12	.09	.14	8.65	<.001
Marijuana	31	.15	.12	.18	8.84	<.001
Purple drank	3	.19	−.01	.38	1.91	.06
Club drugs	17	.23	.14	.32	5.00	<.001
Alcohol	33	.24	.16	.32	5.59	<.001
Sedatives	1	.32	.30	.34	28.47	<.001
Crack cocaine	1	.37	.35	.39	33.35	<.001
Prescription drugs	1	.71	.66	.75	19.74	<.001
Tobacco, marijuana, alcohol	13	.20	.15	.24	8.62	<.001
Multiple illicit drugs	10	.09	.05	.13	4.04	<.001
Music format						
Audio	18	.20	.17	.23	13.07	<.001
Videos	7	.19	.14	.24	7.04	<.001
Preference	69	.16	.13	.19	10.25	<.001
Venue	39	.22	.16	.29	6.33	<.001
Night clubs	1	.11	.04	.18	3.07	.002
General music media	2	.14	.11	.16	8.89	<.001
Music genre						
Reggae	5	.06	.04	.09	4.83	<.001
Country	6	.11	.04	.17	3.14	.002
High-brow	10	.07	.02	.12	2.80	.01
Rock	19	.09	.06	.11	6.84	<.001
Top charts	5	.16	.07	.25	3.49	<.001
Pop	9	.17	.13	.21	8.31	<.001
Electronica	28	.28	.21	.35	7.12	<.001
Urban	17	.12	.07	.17	5.06	<.001
Not specified	30	.21	.18	.24	13.05	<.001
Multiple genres	7	.48	.19	.69	3.08	<.001
Participant race						
White non-Hispanic	108	.16	.14	.19	13.64	<.001
Racial minority	28	.27	.10	.42	3.17	<.001
Participant age						
Adolescent	40	.17	.14	.20	11.37	<.001
Emerging adult	96	.19	.15	.24	8.70	<.001
Study design						
Cross-sectional	128	.17	.14	.19	13.60	<.001
Experimental	2	.89	−.76	1.00	1.16	.25
Longitudinal	6	.23	.15	.31	5.49	<.001
Study location						
Denmark	20	.08	.06	.10	6.87	<.001
Norway	1	.38	.33	.43	14.74	<.001
Netherlands	23	.22	.16	.28	7.03	<.001
Canada	4	.15	.03	.26	2.48	.01
Belgium	9	.20	.14	.26	6.51	<.001
Europe	5	.18	.11	.25	4.74	<.001
United States	64	.21	.16	.25	8.26	<.001
Australia	10	.16	.10	.22	5.00	<.001

Note. k = number of studies; *r* = mean correlation coefficient; CI_{LL} and CI_{UL} = lower limit and upper limit of the 95% confidence interval.

different from the overall effect size indicates that no single study made a disproportionate contribution to the overall effects.

The possibility of publication bias was also examined for substance use using a funnel plot that included study precision (1/standard error) on the *y* axis and Fisher's Z on the *x* axis. In this plot, larger, more-precise studies typically cluster closer around the mean effect than do smaller, less-precise studies, which tend to spread out toward the bottom of the plot (Borenstein et al., 2009). Publication bias is likely if less-precise studies with smaller-than-average effects are missing from the bottom left of the plot. In the present case, no indication of publication bias was found for substance use. We also used Duval and Tweedie's (2000) trim-and-fill method to remove extreme low precision studies from the bottom right of the funnel plot and to obtain an estimate of the mean in the absence of a publication bias. Consistent with the assessment of the funnel plot, the trim-and-fill algorithm did not identify any studies to be trimmed.

Moderation effects for substance use

A Q test of homogeneity of variance indicated significant heterogeneity among correlations for substance use, Q_w (135) = 7,816.45, $p < .001$. Consistent with this, the I^2 (Higgins & Thompson, 2002) indicated that a somewhat large percentage (98.27%) of the variation in effect sizes for substance use between studies was due to systematic variation, rather than random sampling error. As such, moderator variables were examined.

Substance type

Studies were compared based on the substance type examined (i.e., tobacco, alcohol, marijuana, sedatives, prescription drugs without a prescription, crack, purple drank, club drugs, multiple illicit drugs, summed score combining use of tobacco, marijuana, and alcohol). Significant moderating effects were found for substance type examined, Q_B (9) = 573.77, $p < .001$. The smallest effect of music on substance use was found for studies that examined multiple illicit drugs simultaneously ($k = 10$, $r = .09$, $Z = 4.04$, $p < .001$, 95% CI [.05, .13]), followed by tobacco ($k = 26$, $r = .12$, $Z = 8.65$, $p < .001$, 95% CI [.09, .14]), marijuana ($k = 31$, $r = .15$, $Z = 8.84$, $p < .001$, 95% CI [.12, .18]), purple drank ($k = 3$, $r = .19$, $Z = 1.91$, $p = .06$, 95% CI [−.01, .38]), a summed score combining use of tobacco, marijuana, and alcohol ($k = 13$, $r = .20$, $Z = 8.62$, $p < .001$, 95% CI [.15, .24]), club drugs ($k = 17$, $r = .23$, $Z = 5.00$, $p < .001$, 95% CI [.14, .32]), alcohol ($k = 33$, $r = .24$, $Z = 5.59$, $p < .001$, 95% CI [.16, .32]), sedatives ($k = 1$, $r = .32$, $Z = 28.47$, $p < .001$, 95% CI [.30, .34]), and crack cocaine ($k = 1$, $r = .37$, $Z = 33.35$, $p < .001$, 95% CI [.35, .39]). The largest effect was found for the study that examined the use of prescription drugs without a prescription ($k = 1$, $r = .71$, $Z = 19.74$, $p < .001$, 95% CI [.66, .75]).

Music format

Studies were compared based on music format (i.e., audio lyrics, videos, genre preference, performance venue, night club, and general music media). Significant moderating effects were found for substance use, Q_B (5) = 15.41, $p < .01$. The smallest effect size was found for the one study that examined night clubs ($k = 1$, $r = .11$, $Z = 3.07$, $p = .002$, 95% CI [.04, .18]), followed by general music media ($k = 2$, $r = .14$, $Z = 8.89$, $p < .001$, 95% CI [.11, .16]), genre preferences ($k = 69$, $r = .16$, $Z = 10.25$, $p < .001$, 95% CI [.13, .19]), music videos ($k = 7$, $r = .19$, $Z = 7.04$, $p < .001$, 95% CI [.14, .24]), and audio music ($k = 18$, $r = .20$, $Z = 13.07$, $p < .001$, 95% CI [.17, .23]). Performance venues ($k = 39$, $r = .22$, $Z = 6.33$, $p < .001$, 95% CI [.16, .29]) had the largest effect on substance use.

Music genre

Studies were compared based on music genre (i.e., Top Charts, popular, electronica, rock, urban, high-brow, country, reggae, multiple genres, not specified). Significant moderating effects were found for substance use, Q_B (9) = 94.34, $p < .001$. The smallest effect was found for reggae ($k = 5$, $r = .06$, $Z = 4.83$, $p < .001$, 95% CI [.04, .09]), followed by high-brow ($k = 10$, $r = .07$, $Z = 2.80$, $p = .01$, 95% CI [.02, .12]), rock ($k = 19$, $r = .09$, $Z = 6.84$, $p < .001$, 95% CI [.06, .11]), country ($k = 6$, $r = .11$, $Z = 3.14$, $p = .002$, 95% CI [.04, .17]), urban ($k = 17$, $r = .12$, $Z = 5.06$, $p < .001$, 95% CI [.07, .17]), Top Charts ($k = 5$, $r = .16$, $Z = 3.49$, $p < .001$, 95% CI [.07, .25]), and pop ($k = 9$, $r = .17$, $Z = 8.31$, $p < .001$, 95% CI [.13, .21]). Studies that did not specify the music genre examined ($k = 30$, $r = .21$, $Z = 13.05$, $p < .001$, 95% CI [.18, .24]), those that examined electronica ($k = 28$, $r = .28$, $Z = 7.12$, $p < .001$, 95% CI [.21, .35]), and studies that examined multiple genres that could not be separated for analyses ($k = 7$, $r = .48$, $Z = 3.08$, $p = .002$, 95% CI [.19, .69]) had the largest effects.

Participant race

Studies were compared based on participant race (i.e., non-Hispanic White, minority ethnic groups). No significant moderating effect of participant race was found for substance use, Q_B (1) = 1.58, $p = .21$. Even so, studies conducted with White non-Hispanic participants ($k = 108$, $r = .16$, $Z = 13.64$, $p < .001$, 95% CI [.14, .19]) reported a smaller effect of music on substance use compared to studies that included participants from ethnic minority groups ($k = 28$, $r = .27$, $Z = 3.17$, $p < .001$, 95% CI [.10, .42]).

Participant age

Studies were compared based on participant age. Age was coded as adolescent (13–17 years) and emerging adult (18–25 years). There was no significant effect of participant age on substance use, Q_B (1) = .99, p = .31. However, studies conducted with adolescent participants (k = 40, r = .17, Z = 11.37, p < .001, 95% CI [.14, .20]) reported a smaller effect than studies conducted with emerging adult participants (k = 96, r = .19, Z = 8.70, p < .001, 95% CI [.15, .24]).

Participant biological sex

To investigate whether participant biological sex moderated the size of the relation between music and substance use, a metaregression analysis was conducted. Results indicated a significant relation between the percentage of male participants in each study and the size of the relation for substance use, β = .004, Z = 3.55, p < .001, T^2 = .02, 95% CI [.00, .01]. The proportion of variance between music and substance use explained by participant biological sex was .02.

Location

Studies were also compared based on location (i.e., United States, Australia, Belgium, Canada, Europe, Netherlands, Norway, Denmark). A significant moderating effect of study location was found for substance use, Q_B (7) = 142.55, p < .001. The studies conducted in Denmark (k = 20, r = .08, Z = 6.87, p < .001, 95% CI [.06, .10]) had the smallest effects, followed by studies conducted in Canada (k = 4, r = .15, Z = 2.48, p < .01, 95% CI [.03, .26]), Australia (k = 10, r = .16, Z = 5.00, p < .001, 95% CI [.10, .22]), Europe (k = 5, r = .18, Z = 4.74, p < .001, 95% CI [.11, .25]), Belgium (k = 9, r = .20, Z = 6.51, p < .001, 95% CI [.14, .26]), the United States (k = 64, r = .21, Z = 8.26, p < .001, 95% CI [.16, .25]), and the Netherlands (k = 23, r = .22, Z = 7.03, p < .001, 95% CI [.16, .28]). The single study conducted in Norway (k = 1, r = .38, Z = 14.74, p < .001, 95% CI [.33, .43]) had the largest reported effects.

Study design

Studies were compared based on research design (i.e., cross-sectional, longitudinal, experimental). No significant moderating effects of study design were found for substance use, Q_B (2) = 3.48, p = .18. However, studies conducted using cross-sectional designs (k = 128, r = .17, Z = 13.60, p < .001, 95% CI [.14, .19]) reported the smallest effect, followed by longitudinal design (k = 6, r = .23, Z = 5.49, p < .001, 95% CI [.15, .31]) and then experimental designs (k = 2, r = .89, Z = 1.16, p = .25, 95% CI [−.76, 1.00]).

Discussion

Interpreting the overall effect

The present meta-analysis found a significant positive relation between music and substance use. The *r* value for the relation between music and substance use was .19. Our study is the first meta-analysis on the relationship between music and consumer substance use. The current meta-analysis included a total of 136 studies, bringing our total sample size to 330,652, substantially increasing the power of the test (Levine, 2013). This indicates that our effect size is probably an accurate indicator of the effects of music and substance use.

One way to interpret the size of the effects is to consider them in relation to Cohen's (1988) effect size benchmarks, which proposed that *r* values around the .10, .30, and .50 marks should be considered small, medium, and large, respectively. Hence, the overall effects in the present meta-analysis can be classified as small. However, the effect for substance use approached the cutoff point to be considered a medium effect. In addition, the effect was larger than .10, which is the minimal level for the effect to not derive from trivial effects. Given this interpretation, it is inappropriate to focus on the size of the overall relation (Borenstein et al., 2009; Hunter & Schmidt, 2004). Instead, it is more appropriate to consider the size of the effect for each music format and genre to determine whether it is pertinent to consider whether policy makers should be concerned about this effect or whether it can be dismissed as inconsequential. However, even small effects (e.g., .03) can have important real-world implications (McCartney & Rosenthal, 2000), indicating that the effect found in this meta-analysis is not inconsequential.

In addition, when examining the effect of various music formats (i.e., audio lyrics, videos, genre preference, performance venue, night clubs, and general music media) on the outcome variable, we see some variation in effect size. While we did not expect to see significant moderating effects for music format on substance use, it is interesting that music performance venues (.22) had the largest effect on substance use behaviors, followed by audio music (.20), music videos (.19), music genre preferences (.16), general music media (.14), and night clubs (.11). These variations may be related more to the culture of specific music genres that associate substance use with music, specifically rap and hip-hop, rock, and dance/electronica (Hart et al., 2014; Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015). Future research would need to examine this possibility more thoroughly as well as the implications for such findings.

Considering the variations in the nature of substance use references in music based on genre (Hart et al., 2014; Herd, 2008; Oberle & Garcia, 2015; Oksanen, 2012; Mulder et al., 2009; 2010; ter Bogt & Harakeh, 2012), we expected to see significant moderating effects of music genre on substance use. While this was the case, studies that examined multiple genres that could not be separated (.48), electronica (.28), and studies that did not specify the music genre examined in their study (.21) reported the largest effect. Of the studies that permitted the separation of music genres, the smallest effect was reported for reggae (.06), followed by high-brow (.07), rock (.09), country (.11), urban (.12), Top Charts (.16), and pop (.17). These results may also be related to specific music subcultures considering that substance use is generally referenced more frequently in some music genres (e.g., urban, rock, Top Charts/popular) than others (e.g., country, high-brow) (Hart et al., 2014; Herd, 2008; Lim et al., 2008; 2010; Mulder et al., 2009; 2010; Oberle & Garcia, 2015; Oksanen, 2012; ter Bogt & Harakeh, 2012). In addition, some music genres (e.g., electronica) are more frequently associated with the club scene, where substance use is more common (Oberle & Garcia, 2015; ter Bogt & Harakeh, 2012). While reggae music references substance use in some of its songs, these references tend to be limited to marijuana use and are often associated with religious experiences or medicinal purposes (Brunick, 2011). This may partly explain why reggae music was not highly associated with substance use among consumers.

Furthermore, considering the culture of specific music genres that tend to associate substance use with music (Hart et al., 2014; Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015), we also examined the relationship between music and the type of substances used by consumers (i.e., tobacco, alcohol, marijuana, sedatives, prescription drugs without a prescription, crack, purple drank, club drugs, multiple illicit drugs, summed score combining use of tobacco, marijuana, and alcohol). Differences were found based on the type of substances used, with music having the largest effect for the use of prescription drugs without a prescription (.71), followed by the use of crack cocaine (.37), sedatives (.32), alcohol (.24), club drugs (.23), purple drank (.19), marijuana (.15), and tobacco (.12). For the studies that did not permit the separation of specific types of substances used, music was related to both the use of tobacco, marijuana, and alcohol (.20) and multiple illicit drugs (.09). These results are not surprising considering the increase in substance use references in music (Christenson et al., 2012; Kam et al., 2014; Pettigrew et al., 2017; Russell et al., 2017) and the frequent references to alcohol, tobacco, marijuana, ecstasy, MDMA, and other illicit drugs in music (Baker & Moore, 2012; Cranwell et al., 2017; Diamond et al., 2006; Markman, 2012; Primack et al., 2009; Smith et al., 2017). In addition, the majority of substance use references in music link use with positive outcomes (Cranwell et al., 2017; Diamond et al., 2006; Pettigrew et al., 2017) and neglect to mention negative consequences of substance use (Hart et al., 2014). Furthermore, fans of certain music genres (e.g., hip-hop, rock, electronica) are more likely to use substances because drugs are often connected to the genre's culture (Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015).

Moderation effects

The current meta-analysis found a moderating effect of biological sex for substance use. While the proportion of variance between music and substance use that was explained by biological sex was .02, as the percentage of male participants increased in a study so did the substance use reported in the study. It is likely that this may be related to boys and men preferring rap music (Ross, 2006), increasing their exposure to substance use references in music. Previous research has reported that rap music contains references that glamorize, overemphasize, and exaggerate use of numerous substances (Inkster & Sule, 2015) including ecstasy (Diamond et al., 2006), MDMA (Baker & Moore, 2012; Diamond et al., 2006), and purple drank (Hart et al., 2014). Research has also found that participants who prefer rap music are at an increased risk for substance use (Diamond et al., 2006; Herd, 2008; Markert, 2001; Miller et al., 2016; Mulder et al., 2009). In addition, most rap artists are men, increasing the vulnerability for male consumers who may view music artists as respected and similar to themselves (Brown, 2002; Cranwell et al., 2017; Diamond et al., 2006; Knobloch-Westerwick et al., 2008; Kohn, 1969; 1983; Rigg & Estreet, 2018; Slater & Henry, 2013; Smith et al., 2017).

While substance use during adolescence and emerging adulthood is concerning due to the negative consequences associated with it (Badon et al., 2002; Cranwell et al., 2017; Giorgi et al., 2006; Lamers et al., 2003; Miller et al., 2016; Polednak, 2008; Soar et al., 2001; ter Bogt & Harakeh, 2012; Yoon et al., 2011), we did not find a moderated effect of age for substance use. Even so, studies conducted with emerging adult participants (.19) reported a slightly larger effect than studies that focused on adolescent participants (.17). This may indicate that the strong focus on identity development, exploration, and role transitions that emerge during adolescence (Arnett, 2000; Kam et al., 2014; Lonsdale & North, 2011; Miller et al., 2016; Roe, 1999; ter Bogt & Soitos, 2007; Thomas, 2016) and continue through emerging adulthood (Arnett, 2004; Grotevant, 1998; Waterman, 1999) represent a continuous process during development. This continuous process would help explain why music plays an important role in adolescent identity formation (Gardikiotis & Baltzis, 2012; North et al., 2000; Tarrant et al., 2002; Zillmann & Gan, 1997) and continues to do so during emerging adulthood (Rentfrow & Gosling, 2007; Tekman & Hortaçsu, 2002).

We also did not find a moderated effect of participant race for substance use. This is most likely due to how participant race was coded for the meta-analysis (White non-Hispanic; ethnic minority group). We coded race in this manner due to how researchers used convenience sampling in their studies, making it quite difficult to code accurately for participant race to determine generalizability of research findings. Even so, approximately 79% of the studies included in this meta-analysis contained a sample with the majority of participants being White non-Hispanic. This is likely related to the fact that the majority of research that has been conducted in this area has taken place in locations where the majority of residents, and thus research participants, are White non-Hispanic. This limits the diversity of participants represented in this meta-analysis. Unfortunately, limitations on sample size for racial minority participants within the research studies included in this meta-analysis precluded analyzing results separately by specific race. Thus, there may be differences across racial groups within these studies that remain undiscovered.

Regardless of the lack of moderation, studies where the majority of participants were White non-Hispanic (.16) reported a smaller effect compared to studies where the majority of participants included racial minority groups (.27). This was not surprising considering the racial variations in substance use that have been documented in previous research (Hart et al., 2014; Kam et al., 2014; Primack et al., 2010), the music genre preferences that have been associated with race (Gaille, 2015), and the increase in substance use references contained in music (Christenson et al., 2012; Kam et al., 2014; Pettigrew et al., 2017). However, this does not negate the serious nature of these findings. Substance use has numerous negative consequences, such as criminal behavior, unprotected sexual intercourse, substance dependence, and negative health outcomes (Badon et al., 2002; Cranwell et al., 2017; Giorgi et al., 2006; Lamers et al., 2003; Polednak, 2008; Soar et al., 2001; Yoon et al., 2011). Racial disparities in negative effects are also concerning (Polednak, 2008; Yoon et al., 2011). It may be that racial minority groups are more vulnerable to the negative influence of substance use references in music because of the subculture associated with certain music genres that associate substance use with music (Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015), connecting the music subculture with racial identity (Ayanna, 2007; Hikes, 2004; Shildrick & MacDonald, 2006) and viewing music artists as respected and similar to themselves (Brown, 2002; Cranwell et al., 2017; Diamond et al., 2006; Knobloch-Westerwick et al., 2008; Kohn, 1969; 1983; Rigg & Estreet, 2018; Slater & Henry, 2013; Smith et al., 2017).

We also examined potential moderating effects of study location and design (i.e., cross-sectional, longitudinal, experimental) on substance use. While we found no significant moderating effect of study design, we did find a significant moderating effect of study location. The study conducted in Norway yielded the largest effect for substance use (.38), followed by studies conducted in the Netherlands (.22), the United States (.21), Belgium (.20), Europe (.18), Australia (.16), Canada (.15), and Denmark (.08). These results also help explain the lack of a moderated effect based on participant race as the majority of research has been conducted in countries containing a high percentage of White non-Hispanic residents. In terms of research design, despite the lack of moderation, studies using a cross-sectional design (.17) reported the smallest effect, followed by longitudinal designs (.23). Experimental designs were found to have the largest reported effect (.89). However, that effect was not significant in this meta-analysis ($p = .25$).

Theoretical explanation

Taken together, the results of this meta-analysis lend support to the uses and gratifications paradigm (Katz et al., 1973; Rubin, 2009), the cultivation framework (Cohen & Weimann, 2000; Gerbner et al., 1994), and viewing music as a "super peer" (Ward et al., 2011) for adolescent and emerging adult consumers, particularly boys and men from racial minority groups. Because of the culture of specific music genres associating substance use with music (Hart et al., 2014; Lim et al., 2008; 2010; Mulder et al., 2009; Oberle & Garcia, 2015), it may be that consumers engage in substance use and seek out specific music artists to conform to the music subculture (Bleakley et al., 2008). The more adolescents and emerging adults then engage with music, the more likely they are to believe that what is portrayed in the music is real (Cohen & Weimann, 2000; Gerbner et al., 1994) and link substance use with positive outcomes, such as success, wealth, glamour, partying, sexual activity, and socializing (Cranwell et al., 2017; Diamond et al., 2006; Pettigrew et al., 2017). In addition, because young consumers view music as a "super peer" (Ward et al., 2011), they are more likely to be influenced by music to engage in substance use. This seems to be particular relevant to boys and men from racial minority groups, who may connect the music subculture with racial identity (Ayanna, 2007; Hikes, 2004; Shildrick & MacDonald, 2006) and view music artists as respected and similar to themselves (Brown, 2002; Cranwell et al., 2017; Diamond et al., 2006; Knobloch-Westerwick et al., 2008; Kohn, 1969; 1983; Rigg & Estreet, 2018; Slater & Henry, 2013; Smith et al., 2017).

Limitations of study

Within the meta-analysis, there are some limits to the strength of our findings. In addition to the variations of results derived from differing research designs utilized in this field, current research in this area is rather limited, yielding 36 studies for inclusion in our review. This is partly because we limited media to music. The lack of standardization in terms of specific variables in previous research (e.g., music formats) can also be a limitation. Limitations on sample size for racial minority participants within the research studies included precluded analyzing results separately by specific race. Thus, there may be differences across racial groups within these studies that remain undiscovered. In addition, we did not correct for study artifacts (Hunter & Schmidt, 2004). As such, the true size of the relationship between music and substance use behaviors among consumers is higher than the observed effect sizes reported here.

Significance of the study and implications for future research

Results of this meta-analysis indicate that music is not the only risk factor associated with substance use. Moderating variables, in addition to music format, music genre, and type of substance used, played a role in the relation between music and substance use, particularly participant biological sex and the location of the study. While participant race was not a significant moderator in this meta-analysis, differences in effect size were found for White non-Hispanic participants and participants from racial minority groups. It may be more accurate to point out that music content likely combines with some of these factors to increase the risk for substance use among consumers. For eaxmple, it appears as though boys and men from racial minority groups may be more vulnerable to the potential negative influence of music when it comes to substance use. This information should be helpful to those involved in the criminal justice system, sexual health education, drug use prevention, the general education system, and health care and has broad significance, given the racial disparities and biological sex differences that exist in these areas (e.g., Polednak, 2008; Yoon et al., 2011).

Although the results of this meta-analysis help answer questions regarding the relationship between music and substance use, they also pose implications for future research within this domain. Future research should consider whether substance use related to music is potentially related to a third common variable, one that impacts music consumption and substance use. Perhaps biological sex is this common variable, making these results nothing more than a spurious effect related to biological sex. In addition, future research should examine music in the socialization process more thoroughly, including aspects of parental and peer influences as they are often related to substance use behaviors (Kam et al., 2014; Mulder et al., 2010; Pettigrew et al., 2017; Slater & Henry, 2013; Smith et al., 2017). The association of music subcultures and racial identity development needs to be addressed more thoroughly (Ayanna, 2007; Hikes, 2004; Shildrick & MacDonald, 2006), especially in relation to the development of boys and men. Finally, risk factors associated with limited parental and peer positive socialization regarding substance use should also be considered in future research examining the impact of music and other forms of media on substance use.

Disclosure statement

No potential conflict of interest was reported by the authors.

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