We conducted a systematic content analysis of public health Web sites in the United States for information regarding marijuana use and its health impact. We included 50 states and the District of Columbia and 5 federal public health agencies' Web sites (Administration for Children and Families [ACF], Centers for Disease Control and Prevention [CDC], Health Resources and Services Administration [HRSA], National Institute on Drug Abuse [NIDA], and Substance Abuse and Mental Health Services Administration [SAMSHA]). We used the search function on each agency's Web site to search for the terms (marijuana or cannabis or hemp) and (pregnancy or pregnant or prenatal or perinatal). If the agency's search function did not produce any results, we additionally conducted a Google search with the aforementioned search terms in addition to the name of the public health agency to ensure that we identified all relevant content. We saved all Web content as a PDF file to be used for coding, and so that we are able to access the item in the future, as Web links are not stable over time.[21] (A comprehensive list of all Web pages that we accessed, the corresponding dates the searches were conducted, and a PDF file of any content, as of the date accessed, is available from the authors upon request.)

Coding instrument development

We use directed content analysis methods to identify and code content about the risks or benefits of perinatal marijuana use, which allowed us to create categories of content related to our a priori outcomes of interest, as well as to address related categories of content that occur in the data.[22] We developed a 12-item coding instrument that included codes related to content about target populations (nonpregnant adult, pregnant women/fetus/infant, partner to pregnant woman, male reproductive, or childhood); mode of consumption (combustible inhalation, edible, transdermal, or noncombustible inhalation); or perinatal health (legal implications, quitting, or safety/parenting). These content domains included in our coding instrument were developed based on prior qualitative research with pregnant women who used marijuana and obstetric providers. Specifically, our prior qualitative work with pregnant women revealed that they often used Web searching as a tool to obtain information about marijuana's effects on fetal and infant health and that they felt that health care providers were not providing adequate information about marijuana use.[23] Prior work with obstetric providers showed that they were not aware of identified risks of perinatal marijuana use.[24] We created a coding scheme that included codes for a priori outcomes. We pilot-tested the coding instrument in a random sample of 14 Web pages about perinatal marijuana use that were not from US public health agencies (i.e., content from English language non-US public health agencies or content from consumer medical Web sites). Two authors (M.J., J.Z.) separately coded the first 5 pilot media items, met to compare codes, discussed inconsistency in coding approaches, and then altered or added codes for content not related to predetermined outcomes. They repeated this process for the remaining items to develop the coding instrument (Table A1 shows the full coding instrument).

After pilot testing of the instrument was complete, 2 authors (M.J., J.Z.) then independently coded all content about perinatal marijuana use published by state and federal US public health agencies. We used prevalence- and bias-adjusted kappa statistics, which provide a measure of interrate reliability that is adjusted to assess reliability for binary items where "yes" and "no" values are not evenly distributed.[25] Interrater reliability was moderate to excellent, with prevalence- and bias-adjusted κ ranging from 0.58 to 1.00 and mean $\kappa = 0.87$. (Table A2 shows raw agreement, Cohen's κ, and prevalence- and bias-adjusted κ for each specific item.) Where there was disagreement in coding for specific items, the 2 coders discussed and reached agreement for the final analytic dataset.

Analysis

We conducted descriptive statistics to assess the characteristics of public health agency Web sites with perinatal marijuana content and to determine the frequency with which specific quantitative items were mentioned. For information related to perinatal use, we also grouped text into themes about health effects, legal implications, quitting marijuana use, and safety/parenting and present illustrative quotes for these themes.

Results

Ten state public health agencies and 1 federal agency (National Institute on Drug Abuse [NIDA]) had published content pertaining to perinatal marijuana use. Among the state agencies with published information about perinatal marijuana, 5 states did not permit marijuana use, 4 states permitted marijuana for medical and recreational use, and 1 state permitted marijuana for medical use only. Most public health agency content (8 agencies) was targeted to the lay public, although 3 agencies had published content about perinatal marijuana use targeted to health care providers. The mean word count of published content was 1149 (SD: 168).

Figure 1 show the frequency with which public health agency Web sites' content pertaining to perinatal marijuana included information on specific topics. Among the 11 agencies with perinatal marijuana use content, 2 mentioned marijuana use among women's partners, 2 mentioned marijuana use and male reproductive health, and 3 mentioned in utero exposure to marijuana among children aged 1–9. Most agencies mentioned combustible inhalation of marijuana ($n = 10$) or edible marijuana ($n = 8$). Eight of 11 agencies mentioned marijuana use and breastfeeding, 5 mentioned quitting marijuana in the perinatal period, 5 mentioned safety or parenting and marijuana use, and 3 mentioned legal implications of perinatal use.

Content for lay public audiences

Content published by public health agencies typically highlighted effects on infants and children, although the specific health effects mentioned varied across states (Table 1). Among published content about perinatal health effects targeted to the lay public, information ranged from blanket

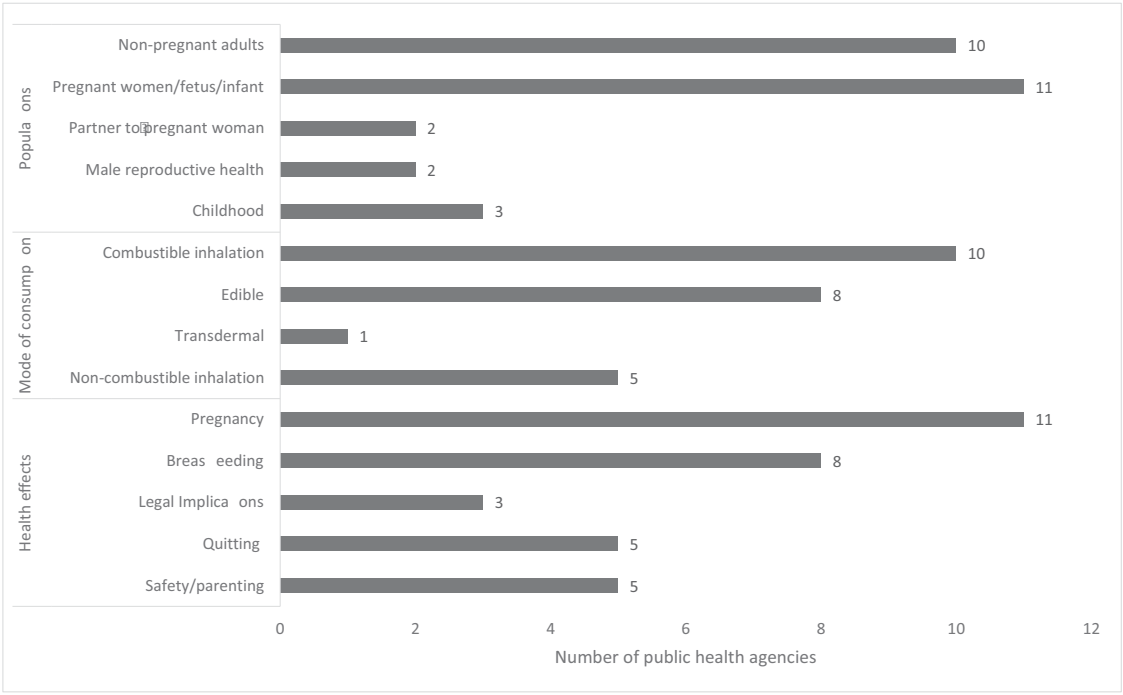

Figure 1. Frequency of specific content items in public health agency websites pertaining to perinatal marijuana use. Data based on Internet searches conducted in February 2016 of public health agencies for 50 states and the District of Columbia, and 5 federal public health agencies.

Table 1. Illustrative examples of content pertaining to perinatal marijuana use contained in public health agency Web sites.

Theme	Illustrative example
Health effects among women, fetuses, or infants	*Public audience*: "Some studies have suggested that among women who smoke marijuana cigarettes regularly, there is an increased chance for pregnancy complications such as: premature birth, low birth weight, stillbirth and small length and small head circumference. Babies that are born prematurely or with low birth weight can have higher rates of infant deaths, learning problems or other disabilities. Similar to what is seen with cigarette smoking, smoking marijuana may increase carbon monoxide levels in the blood, which can decrease the amount of oxygen the baby receives, and may also affect the growth of the baby." *Health care provider audience*: "Use of marijuana during pregnancy is associated with negative effects on exposed children, no matter when it is used during pregnancy. The negative effects include decreased academic ability, cognitive function and attention. These effects may not appear until adolescence."
Health effects during breastfeeding	*Public audience*: "Marijuana can be passed to infants through their mother's breast milk. Marijuana may also affect the quality and quantity of breast milk that you make." *Health care provider audience*: "Discuss importance of cessation of marijuana and other potentially harmful substances during pregnancy and breastfeeding and offer support if needed … Discuss patient's plan for marijuana use after pregnancy. …Discuss breastfeeding and marijuana."
Legal implications of perinatal use	*Public audience*: "Some hospitals test babies after birth for drugs. If your baby tests positive for THC at birth, [state] law says child protective services must be notified." *Health care provider audience*: "…[H]ealth care providers are mandated reporters and required to notify [child protective services] when there is reasonable cause to believe a child has been abused or neglected. If a newborn has been identified as substance exposed or affected, this may indicate child abuse/neglect and should be reported. It is critical that mandated reporters provide as much information regarding concerning issues/behaviors, risk factors or positive supports that were observed during the interaction with the family."
Quitting marijuana in the perinatal period	*Public audience*: "Talk to your doctor if you're pregnant, thinking about becoming pregnant, or breastfeeding and need help to stop using marijuana." *Health care provider audience*: "Treatment for substance abuse during pregnancy can be more effective than at other times in a woman's life. …Pregnant women often describe their healthcare providers as the best source of information and generally follow their advice."
Perinatal use and safety or parenting	*Public audience*: "Marijuana can make children very sick. Look for problems walking or sitting up, starting to be sleepy or having a hard time breathing." *Health care provider audience*: "Marijuana use can affect a person's ability to care for a baby. It is appropriate to ask about marijuana or other substance use before letting a person care for a baby."

statements (e.g., "There is no known safe amount of marijuana use during pregnancy") to lists of adverse effects (e.g., "there is an increased chance for pregnancy complications such as: premature birth, low birth weight, stillbirth and small length and small head circumference"). Three agencies explicitly described scientific uncertainty about the causal effects of perinatal marijuana use, and 1 state mentioned the difficulty in drawing inference from observational data: "It can be difficult to draw conclusions from these studies because most of the women who used marijuana also used other substances at the same time or had other factors that may have increased their chance for these defects." All 8 agencies mentioning breastfeeding stated that marijuana can be passed to infants via breast milk. Some agencies ($n = 3$) mentioned that infants exposed to marijuana might have trouble feeding.

Five public health agency Web sites mentioned that pregnant women should stop using marijuana. These agencies universally directed women to talk to a doctor or other health care provider. Colorado, where marijuana has been legal for medical and recreational purposes since January 2014, also included a toll-free telephone number that pregnant or breastfeeding women could call for help to stop using marijuana.

Content for health care providers

Three states had information targeted to health care providers. Notably, these states (Alaska, Colorado, Washington) all have laws permitting recreational use of marijuana among adults. These documents generally discussed health effects of marijuana use in the perinatal period; for example, one state agency noted that "emerging research … suggests there is an association between marijuana and decreased fetal growth, development and executive functioning and mood disorders in children." Content targeted to health care providers also included information about states' policies pertaining to the circumstances under which health care providers are required to report prenatal substance use to child protective agencies. Two state agencies noted that mandatory reporting is required if health care providers "have a suspicion of abuse or neglect (i.e., that the health or welfare of a child is threatened)." The third state agency noted that reporting to a child protective agency is required for "newborns identified as being AFFECTED by illegal substance abuse or withdrawal symptoms resulting from prenatal drug exposure."

Discussion

In our study of all state public health agency Web sites and 5 federal health agency Web sites, we found that 11 contained published content about perinatal marijuana use. All state agencies included information about health effects related to in utero exposure to marijuana, and most ($n = 8$) also stated that marijuana can be passively consumed by an infant during breastfeeding. Content pertaining to health effects of perinatal marijuana use varied across state agencies, with public health messages ranging from broad statements about risk to more narrow messages about specific health effects. Fewer agencies had published messages about behaviorally based health risks to infants that occur with safety/parenting and marijuana use. Although public health agencies' content generally conveyed that perinatal marijuana use is associated with adverse effects, less than half of the content included resources to help individuals stop using marijuana in the perinatal period.

In light of emerging scientific evidence about the health risks to women, infants, and children from perinatal marijuana use, public health agencies face a challenging decision about whether or how to communicate potentially conflicting data to the lay public or health care providers. That we found only 10 state public health agencies had published such communications might reflect this challenge. In general, those states with published content often included information about health risks of perinatal marijuana use, but less frequently addressed the issue of scientific uncertainty in public communications. Public health agencies also face a challenge in disseminating credible information to the public about potential risks of perinatal marijuana use in an era when youth and younger adults increasingly believe marijuana use to be low risk or beneficial.[26] Nevertheless, there are at least 2 important reasons why public health agencies should consider disseminating information about perinatal marijuana use. First, current public opinion is likely to be heavily shaped by political and commercial messages about marijuana—for example, the public is already being exposed to marketing communications intended to promote marijuana use for recreational purposes.[27] This suggests a role for public health agencies to monitor and communicate unbiased findings. Second, women who have used marijuana during pregnancy report that they desire information about the risks of perinatal marijuana use and report actively seeking such information on the Internet or from family and friends.[23] Such research suggests that pregnant women would be receptive to information about how marijuana use might affect the health and well-being of infants and children.

In the 3 states where recreational marijuana is legal, public health agencies have published content about perinatal marijuana use for health care providers. Content aimed at providers included scientific information about health risks and treatment for dependent patients. Dissemination of such information to providers may be useful because of women's and infants' frequent engagement with the health care system during the perinatal period. Recent research suggests that obstetric providers describe limited knowledge about potential consequences of perinatal marijuana use,[24] and their responses to pregnant patients' disclosure of use of marijuana use often focus more on punitive consequences than medical implications.[28] Public health communications targeted to providers may serve a valuable role in summarizing emerging evidence pertaining to both health effects of perinatal marijuana use as well as best practices for screening and treatment.

This study has limitations. First, our analysis included state and federal public health agencies in the United States, so findings are likely not generalizable to other media about perinatal marijuana use, such as blogs or news Web sites. Second, our data were collected during one point in time

(early 2016), so we are not able to assess changes over time in the public health messages about perinatal marijuana use. Given that policies legalizing marijuana for recreational use are relatively recent, however, we would expect that our data reasonably represent public health messages since the enactment of such policies. Third, our study is descriptive in nature, and we are unable to identify what proportion of pregnant or postpartum women are exposed to the public health messages about perinatal marijuana use or whether such messages lead to behavior changes. A strength of our study is that our content analysis methods involved the development of a codebook to identify common elements in text publications, and we used well-established methods to develop codes and provide quantitative estimate of high interrater reliability.

Conclusion

This systematic content analysis of public health agency Web sites in the United States found that of 56 state and federal agencies, 1 federal agency and 10 state agencies had published information about perinatal marijuana use. Public health messages commonly focused on potential adverse health effects, although the detail in such information varied across states. Fewer than half of agency Web sites provided resources to stop using marijuana in the perinatal period.

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Author contributions

Dr. Jarlenski conceptualized the study design, contributed to data collection, analyzed the data, and approved the final version of the manuscript. Dr. Zank contributed to data collection, critically revised the manuscript for intellectual content, and approved the final version of the manuscript. Ms. Tarr and Dr. Chang contributed to the study design and interpretation of data, critically revised the manuscript for intellectual content, and approved the final version of the manuscript.

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Appendix

Table A1. Full instrument used to code public health content about perinatal marijuana use.

Section 1. Characteristics of Web pages		
Item name	Item	Code
studyid	**Unique Web page ID (e.g., CO_01, CO_02)**	[XXX]
state	**State (e.g., CO or US for federal Web page)**	[XX]
audience	**Target audience** Code the target audience. Code health care provider if content includes language such as: "Tell patients about…" Code both mentioned if the audience seems to be both public and health care providers.	0 = Public 1 = Health care providers 2 = Both mentioned
word	**Word count**	XXXX

Section 2. Content of Web pages		
Item name	Item	Code
Information about the following populations:		
Q1	**Nonpregnant adults** If content is about marijuana use, and does not specify pregnant, infant, child, adolescent, code yes. If content mentions effects of prenatal exposure into adulthood, code yes.	0 = No 1 = Yes
Q2	**Pregnant women/fetus/infant age <1 year** If content mentions effects on fetal and child development, code both pregnancy/fetus and child. Code if mentions "baby, infant, neonate, postneonatal."	0 = No 1 = Yes
Q3	**Partner to pregnant woman (male or female or not specified)** Code if content refers to effects of a pregnant woman's partner's use of marijuana.	0 = No 1 = Yes
Q4	**Male reproductive health/male partner effect on fetus** Code if content specifically refers to male reproductive health. Code if content specifically refers to effects of the biological father's marijuana use on a fetus/infant/child.	0 = No 1 = Yes
Q5	**Childhood (ages 1–9 years)** If content mentions effects on fetal and child development, code both pregnancy/fetus and child. Code if mentions "toddler, child, children, kids, elementary school, pre-schooler."	0 = No 1 = Yes
Mention of the following modes of marijuana consumption:		
Q6	**Combustible inhalation** Code if specifically mentions smoked marijuana or dried marijuana. Code if mentions "smoking." Code if mentions "Lighting a joint/blunt" or "puffing a joint/blunt."	0 = No 1 = Yes
Q7	**Edibles** Code if specifically mentions eating marijuana or edibles.	0 = No 1 = Yes
Q8	**Transdermal exposure (e.g., oil, cream, gel)** Code if specifically mentions marijuana oil or extract oils. Code if mentions creams or gels. Code if mentions "putting on your skin."	0 = No 1 = Yes
Q9	**Non-combustible inhalation (e.g., vaporizer or vaping)** Code if mentions vaping or using a vaporizer.	0 = No 1 = Yes
Information related to perinatal marijuana use:		
Q10	**If information about *maternal/fetus/infant* perinatal health effects, which health effects?** Copy and paste illustrative quote	[Copy and Paste text]
Q11	**If information about *breastfeeding* health effects, which health effects?** Copy and paste illustrative quote	[Copy and Paste text]
Q12	**Any information about *legal implications* of perinatal use?** Code yes if information about child welfare services involvement, prosecution, or driving under the influence if related to perinatal use.	0 = No 1 = Yes
Q13	**If yes to Q12, what information about legal implications?** Copy and paste illustrative quotes.	[Copy and Paste text]
Q14	**Any information about *quitting* and perinatal use?** Content must suggest habitual/regular use followed by quitting to be coded. Code if mentions "trying to quit." Code if mentions "dependence." Code if mentions "regular use." Code if mentions talking to doctor about treatment; e.g., "If you use marijuana, talk to your doctor about quitting." Code yes if pregnant person or partner/family/friends, as long as relates to perinatal period.	0 = No 1 = Yes

(*Continued on next page*)

Table A1. (Continued).

Item name	Item	Code
Q15	**If yes to Q14, what information about quitting?** Copy and paste illustrative quotes.	[Copy and Paste text]
Q16	**Any information about *safety/parenting* and perinatal use?** Content must pertain to children/infants and perinatal use. – If in the same paragraph as perinatal use or if entire document is about perinatal use, code yes. – If mentions safety and "newborn/infant/baby," code yes. Code yes if "keep out of reach of children." Code yes if "overdose." Code yes if mentions safety risk of driving, e.g., traffic injuries or fatalities. Code yes if pertains to ability to parent. Code yes if mentions "co-sleeping."	0 = No 1 = Yes
Q17	**If yes to Q16, what information about safety parenting?** Copy and paste illustrative quotes	[Copy and Paste text]

Table A2. Interrater reliability for quantitative coding of public health agency Web site content pertaining to perinatal marijuana use.

Item[a]	Raw agreement, %	Cohen's κ	Prevalence- and bias-adjusted κ[b]
Mentions effects of marijuana use among the following populations:			
Nonpregnant adults	89	0.78	0.79
Pregnant women/fetus/infant	95	0.64	0.89
Partner to pregnant woman	95	0.77	0.89
Male reproductive health	100	1.00	1.00
Childhood (ages 1–9 years)	95	0.89	0.89
Mentions the following forms of marijuana consumption:			
Combustible inhalation	84	0.58	0.68
Edible	100	1.00	1.00
Transdermal	100	1.00	1.00
Noncombustible inhalation	95	0.89	0.89
Mentions the following:			
Legal implications of perinatal use	95	0.83	0.89
Quitting and perinatal use	95	0.90	0.89
Safety/parenting and perinatal use	79	0.55	0.58

[a]All items are binary measures. Two coders independently coded 19 unique documents from 10 state and 1 federal Web site pertaining to perinatal marijuana use.
[b]Prevalence- and bias-adjusted kappa values account for some items that have very high or very low prevalence.