



Women's attitudes toward practicing cytomegalovirus prevention behaviors

Rosemary Thackeray *, Brianna M. Magnusson

Brigham Young University, Department of Health Science, 4103 LSB, Provo, UT 84602, United States

ARTICLE INFO

Article history:

Received 30 May 2016

Received in revised form 19 September 2016

Accepted 25 September 2016

Available online 28 September 2016

Keywords:

Cytomegalovirus

Communication

Attitudes

Birth defects

Prevention

ABSTRACT

Congenital cytomegalovirus (CMV) infection causes severe disabilities and developmental delays. Women's awareness of CMV is low. Only about half of healthcare providers report counseling women about behaviors to reduce CMV risk and public health education is limited. Routine CMV counseling is not recommended. Providers may lack time to counsel women; other conditions may take priority for counseling; there may be a perception that women are reluctant to follow advice. This cross-sectional descriptive study examined women's attitudes toward CMV prevention behaviors. Data were collected from an online panel of 840 U.S. women 18–40 years of age, who had a child <5 years of age, and were pregnant or planning a pregnancy in the next 12 months. Questions assessed CMV awareness, frequency of past behaviors that transmit CMV, and attitudes toward eight CMV prevention behaviors. Only 15.5% of women were somewhat or very familiar with CMV. Very few women (6.1%) reported hearing from their provider about CMV. Women held positive attitudes toward the CMV prevention behaviors and perceived them as feasible. Least positive attitudes were toward not kissing a child on the lips and not sharing foods. Predictors of positive attitudes were CMV awareness, past behavior, talking to a healthcare provider, and perceived risk reduction. Healthcare providers and public health practitioners should collaborate to increase CMV awareness. Encouraging behaviors to reduce saliva sharing may result in greater gains in reducing CMV infection.

© 2016 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Congenital cytomegalovirus (CMV) infection is the leading cause of infant hearing loss in the United States (Grosse et al., 2008). Women exposed to CMV prior to conception or within the first trimester of pregnancy and then seroconvert have an increased risk of infant infection (Hyde et al., 2010). Congenital CMV infection can result in severe birth defects and developmental delays, including cognitive and motor deficits, vision loss, and death (Dollard et al., 2007). Annually, nearly 26,000 children in the United States are born with CMV; birth prevalence is estimated at 0.64% (Cannon et al., 2014a). Of these, approximately 400 infants will die and 8000 will develop permanent disabilities (Cannon & Davis, 2005).

The virus is spread through sexual contact, breastmilk, organ transplantation, and from mother to baby during pregnancy (Boppana, 2006). Congenital transmission of CMV can occur in utero, during birth or through breastfeeding and is most likely to occur when a mother experiences a primary CMV infection during pregnancy (Schleiss, 2008). Until a vaccine is available (Plotkin, 2015) women can reduce and prevent CMV transmission through practicing appropriate hygiene behaviors (Harrison, 2015; Price et al., 2014). Washing of hands is the

primary recommendation for reducing the spread of CMV (Kimberlin, et al., 2015; Centers for Disease Control and Prevention, 2016). However, viral loads are very high in children's saliva (Cannon et al., 2014a) and behaviors that expose women to saliva put them at increased risk. Studies have shown that doing the following behaviors can reduce risk: avoid contact with saliva when kissing a child, do not put things in your mouth that have been in a child's mouth (specifically food, cups, forks or spoons, or pacifiers), and washing hands after touching a child's saliva or urine, especially after changing a diaper or wiping a nose (Harrison, 2015).

Both general practitioners and obstetrician-gynecologists are key to providing a women's pre-conception care (Mazza et al., 2013; Ranji & Salganicoff, 2011). Studies have shown that counseling-based interventions have been effective in reducing CMV infection (Adler et al., 2004; Revello et al., 2015; Vauloup-Fellous et al., 2009). Fewer than half of healthcare providers report counseling their patients on CMV prevention (Ross et al., 2009). Both general practitioners and obstetrician-gynecologists have indicated that the lack of time during a visit, the number of topics to be discussed, and a lack of knowledge about some topics are barriers to providing women preconception and pregnancy-related information; (Mazza et al., 2013; Ross et al., 2009; Morgan et al., 2012). Providers may preferentially give advice that they perceive will most benefit the patient (Ross et al., 2009) and that the patient may be willing to follow. Additionally, current standards for prenatal care do not include routine screening for, or counseling about, CMV

* Corresponding author.

E-mail addresses: rosemary_thackeray@byu.edu (R. Thackeray), brianna_magnusson@byu.edu (B.M. Magnusson).

(Zolotor & Carlough, 2014; American College of Obstetricians and Gynecologists, 2015). There is limited public education about CMV. As a result, overall CMV awareness ranges between 13 and 39% (Jeon et al., 2006; Pereboom et al., 2013; Willame et al., 2015).

Health behavior theory posits that a person's attitude toward and perceived control over a target behavior are critical in determining whether or not they will perform a behavior (Godin & Kok, 1996). Additional factors that influence a person's response to health messages include their beliefs in the likelihood that they will be affected (susceptibility), how seriously they will be affected (severity), and the belief that they can take action to reduce their risk (response efficacy) (Witte, 1994). If women have positive attitudes toward the CMV prevention behaviors and believe that they can take action to reduce their risk they may be more likely to follow a healthcare provider's recommendation or public health message. Therefore, the purposes of this research were to 1) determine the frequency with which women perform CMV risk and prevention behaviors, 2) understand women's attitudes toward the behaviors and 3) identify what factors predict positive attitudes toward the behaviors.

2. Method

2.1. Sample and participant selection

This was a cross-sectional descriptive study. Data were collected from women in the United States who were members of an online panel operated by Qualtrics, a worldwide software company specializing in market research. Online panels are comprised of participants who have agreed to respond to survey requests in exchange for compensation. The participants had previously consented to be a member of the Qualtrics panel. As members of the panel, people complete a profile of demographic characteristics and interests that allows the survey administrator to target eligible participants. An email invitation, including the approximate survey length and quantity of reward points (equivalent to \$1.10) that would be credited to their account, was sent to potential respondents who met initial demographic criteria of being a female between the ages of 18–40. The study was approved by the university institutional review board.

In addition to age and gender, inclusion criteria were that the woman had a child <5 years of age and was pregnant or planning a pregnancy in the next 12 months. There were two exclusion criteria: having had a child with a previously diagnosed disability and having worked as a healthcare provider. Healthcare providers and parents of a child with a disability may be more aware of CMV than the general population as it causes several birth defects and developmental disabilities. Additional sociodemographic variables measured included race/ethnicity (white, black, Hispanic, other), number of children at home, education, and household income.

Panel members who met the criteria and responded to the email invitation were sent a link to a web-based survey. A one-page factsheet describing CMV was developed based on a previous study of CMV materials (Price et al., 2014) and was embedded in the survey. The text included statements about the likelihood that the woman and her child would be affected, steps to reduce the possibility of infection, and the potential results of following or not following the behavioral guidelines.

2.2. Measures

The dependent variable was women's attitudes toward CMV prevention behaviors. Attitudes toward each of the eight prevention behaviors were assessed using a seven-point semantic differential scale using four different descriptors with words that were opposites: impractical-practical, inconvenient-convenient, difficult-easy, unrealistic-realistic. Higher mean scores indicated more favorable attitudes. The authors developed the attitude scale based on standard semantic differential scales.

CMV related variables included familiarity with CMV, perceptions of the severity of infection, susceptibility to infection, how effective they thought the behaviors would be at reducing risk (response efficacy), and frequency of practicing the behaviors in the past. One question asked how familiar women were with CMV (very familiar, somewhat familiar, or not at all familiar) (Price et al., 2014). Perceived severity of a CMV infection was measured with three questions adapted from Block and Keller (Block & Keller, 1995) about whether the respondent felt that a CMV infection in a baby was frightening, dangerous, or severe. Perceived susceptibility of CMV infection was measured by three items adapted from Nan, Xie, and Madden (Nan et al., 2012) including if it is likely that they would contract CMV, if it is possible that they would get CMV, and if they are at risk for getting CMV. For both perceived severity and susceptibility, responses ranged from strongly disagree (Grosse et al., 2008) to strongly agree (Schleiss, 2008). Total scores were created by averaging the three items for each construct (Cronbach's alpha severity = 0.90; susceptibility = 0.81). Higher values indicated higher perceived severity or susceptibility (range: 1–7).

Practicing prevention or risk behaviors in the past was measured by eight items regarding the frequency of washing hands after changing diapers (two questions) or wiping a child's nose, sharing bites of food, cups, or utensils with children, putting a pacifier in the mouth after it had been in a child's mouth, and kissing children on the lips. (Price et al., 2014) Response options for washing hands ranged from never (Grosse et al., 2008) to always (Cannon & Davis, 2005). The remainder of the questions were also on a 5-point scale (never, rarely, 1–2 days per week, 3–5 days per week and every day).

Perceived response efficacy for each of the CMV prevention behaviors was measured by one item adapted from Taber and Aspinwall (Taber & Aspinwall, 2015). The question asked the respondent how effective they thought each behavior would be at decreasing her risk of getting CMV. Responses ranged from not at all effective (Grosse et al., 2008) to very effective (Cannon & Davis, 2005).

2.3. Statistical analysis

Frequencies and proportions were calculated to describe the sociodemographic characteristics and the prevalence of CMV risk behaviors. We examined the differences in the prevalence of CMV risk behaviors across sociodemographic characteristics using a chi-square test. Measures of central tendency and dispersion were calculated for the four semantic differential measures for each of the eight CMV prevention behaviors. We conducted principal component analysis with varimax rotation on all of the semantic differential measures. A four factor solution with variables clustered by behavior type adequately explained the covariation. The resulting scales were comprised of semantic differential measures for: 1) sharing utensils, cups, or food ($\alpha = 0.97$); 2) washing hands after wet or dirty diapers or wiping a nose ($\alpha = 0.97$); 3) kissing on the lips ($\alpha = 0.96$) and 4) putting a pacifier in your mouth ($\alpha = 0.96$).

Linear regression was used to evaluate the association between the independent variables: sociodemographic characteristics, CMV awareness, having talked to a healthcare provider about CMV, the respondent's participation in the risk behavior, response efficacy, perceived susceptibility and severity to CMV, and the dependent variables: attitudes toward the CMV prevention behaviors. Attitudes were measured by the four scales clustered by behavior-type identified in factor analysis: 1) performing hand hygiene, 2) avoiding sharing behaviors, 3) not kissing a child on the mouth, and 4) not putting a pacifier in the mouth. Using backward elimination, covariates that did not reach significance at $\alpha = 0.10$ were excluded. For the regression models, pre-survey frequency of sharing behaviors, kissing on the lips and putting a pacifier in your mouth were reverse coded so that higher numbers indicated lower frequency of the behavior. All analyses were conducted in SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Table 1
Demographic characteristics for a sample U.S. women aged 18–40 years who are pregnant or planning a pregnancy.

	N = 840
Mean age in year (95% confidence interval)	28.81 (28.50–29.13)
	n (%)
Aware of CMV	
Very familiar	30 (3.6)
Somewhat familiar	100 (11.9)
Not at all familiar	710 (84.5)
Ever talked to a healthcare provider about CMV	51 (6.1)
Race	
White, non-Hispanic	611 (72.7)
Black, non-Hispanic	66 (7.9)
Asian/pacific islander	21 (2.5)
Hispanic	52 (6.2)
Other, non-Hispanic	90 (10.7)
Youngest child at home	
Less than a year	148 (17.6)
1 year old	210 (25.0)
2 years old	205 (24.4)
3 years old	129 (15.4)
4 years old	73 (8.7)
5 years old	75 (8.9)
Currently pregnant	399 (47.5)
Highest education received	
Some high school	14 (1.7)
High school graduate or GED	167 (19.9)
Some college/associate degree	316 (37.6)
College graduate or higher	343 (40.8)
Post graduate degree	80 (9.5)
Annual household income	
<\$25,000	118 (14.1)
\$25,000–\$49,000	273 (32.5)
\$50,000–\$74,999	234 (27.9)
\$75,000–\$99,999	126 (15.0)
\$100,000 or more	89 (10.6)

3. Results

A total of 840 women completed the survey. Only 15.5% ($n = 130$) of women reported that they were somewhat or very familiar with CMV. Very few women (6.1%; $n = 51$) said that their healthcare provider had talked to them about CMV. Of those who said they were somewhat or very familiar with CMV, 34% ($n = 44$) said that a healthcare provider had talked to them about CMV. Demographics of survey respondents can be found in Table 1.

The prevalence of practicing CMV prevention and risk behaviors is illustrated in Figs. 1 and 2. Handwashing is very frequent and most

women do not put a pacifier in their mouth, however kissing a child on the lips and sharing of food and cups are common behaviors.

The prevalence of some CMV risk behaviors differed across sociodemographic characteristics. The age of the youngest child at home was associated with all CMV risk behaviors except for washing hands after changing a poopy diaper, putting a pacifier in their mouth and sharing a cup (Fig. 3).

Tables 2 and 3 show distribution of behaviors by sociodemographic factors. Response categories representing behaviors of highest risk are displayed. Handwashing after wet diapers, wiping noses and kissing on the lips varied by race. More white than black women reported never or rarely washing their hands after wiping a child's nose. Kissing a child on the lips was more common among white compared to black or other race mothers. For washing hands after wiping a nose, about a third of those with some college education did so; this was more frequent than what was observed among the other groups. There were no significant differences by income.

Women's responses across the four semantic differential attitude measures for each behavior were highly correlated with Pearson correlation coefficients ranging from 0.54 to 0.91 (data not shown). The weakest correlation was for attitudes about washing hands after poopy diapers. Fig. 4 shows the box and whisker plots for the four scales measuring women's attitudes toward the CMV prevention behaviors.

Overall, the distribution of attitudes toward handwashing was tightly clustered in the positive as displayed in Table 4. Attitudes toward not sharing cups, food and utensils with children were also largely positive, although the distribution of responses varied more than for handwashing behaviors. Women reported the least positive attitudes toward not kissing a child on the lips and this behavior displayed the most variation in responses.

Linear regression models for women's attitudes toward the feasibility of CMV prevention behaviors are shown in Table 5. Significant predictors of favorable attitudes toward handwashing included respondent's education, increased frequency of past handwashing, and response efficacy for handwashing. Women's attitudes toward avoiding sharing food, cups or utensils were predicted by race/ethnicity, age of the youngest child at home, CMV awareness, perceived severity, decreased frequency of past sharing behaviors and response efficacy. Being aware of CMV and beliefs about response efficacy were associated with the largest increases in sharing attitude scores.

Attitudes toward not kissing a child on the lips were predicted by race/ethnicity, older children at home, CMV awareness, having talked to a healthcare provider about CMV, perceived susceptibility, decreased frequency of past practice of kissing a child on the lips, and perceived response efficacy. Of these, CMV awareness, having talked to a healthcare provider about CMV, and decreased frequency of past kissing on the lips

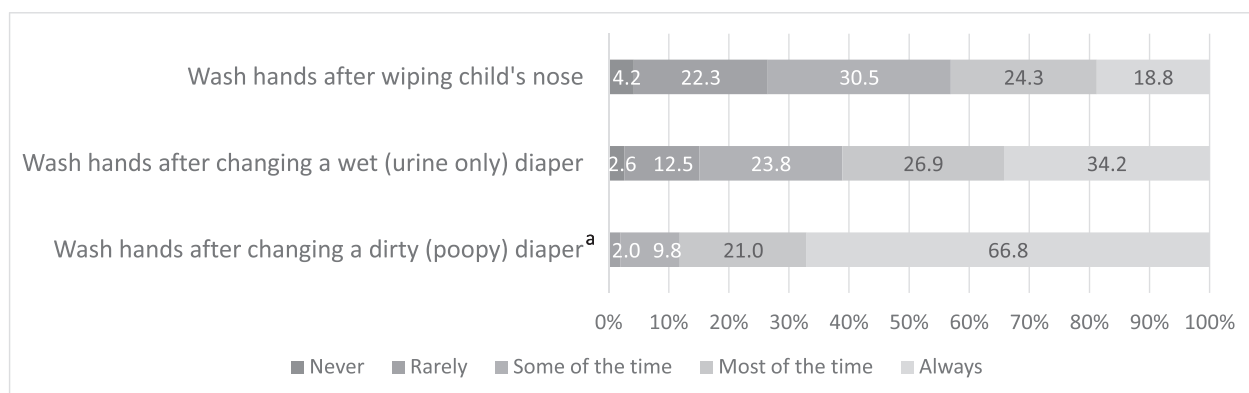


Fig. 1. Prevalence of handwashing behaviors associated with exposure to CMV in a sample of U.S. women 18–40 years of age who are pregnant or planning a pregnancy. Description: The percentage of women who report that they never, rarely, some of the time, most of the time or always wash their hands following three hand hygiene behaviors that are associated with an increased risk of CMV transmission: washing hands following the changing of wet or poopy diapers and washing hands after wiping a child's nose. a: <1% of respondent's reported never washing hands following changing a poopy diaper.

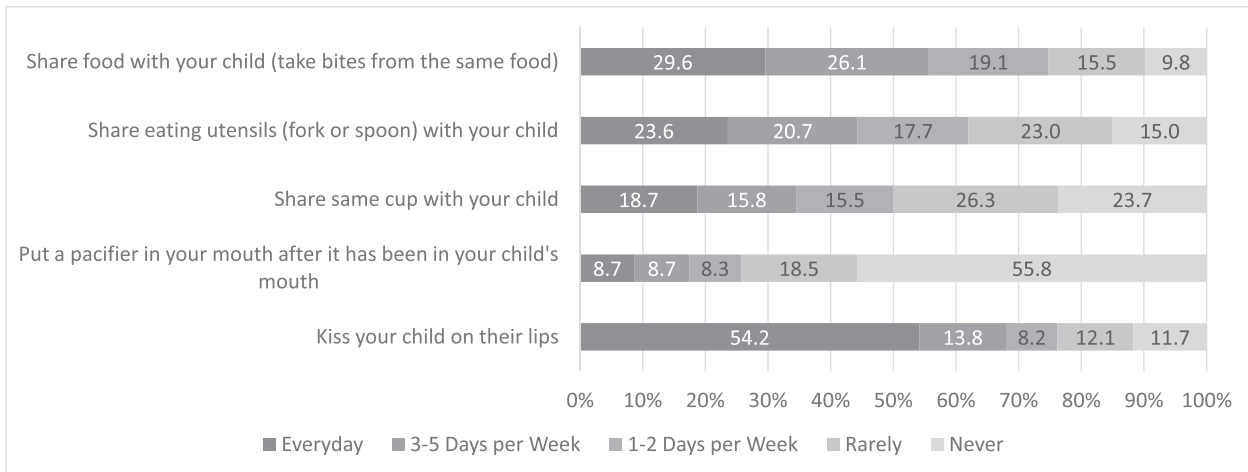


Fig. 2. Prevalence of sharing and kissing behaviors associated with exposure to CMV in a sample of U.S. women 18–40 years of age who are pregnant or planning a pregnancy. Description: The percentage of women who report that they participate in five behaviors which are associated with exposure to a child's saliva and an increased risk of CMV transmission. These behaviors are sharing food, eating utensils, or cups with a child, putting a child's pacifier in your mouth after it has been in a child's mouth and kissing a child on the lips. The response options for frequency were: every day, 3–5 days per week, 1–2 days per week, rarely or never. Increase frequency is associated with higher risk of CMV transmission.

were all associated with the largest increase in kissing attitudes scores. For avoiding putting pacifiers in your mouth, income, past behavior, and response efficacy predicted more positive attitudes. Of these, response efficacy was associated with the largest increase in the pacifier attitudes scale score.

4. Discussion

This study aimed to understand the frequency with which women practice CMV prevention behaviors, women's attitudes toward the behaviors, and predictors of those attitudes. Overall, women have positive attitudes toward practicing these behaviors and perceive them as

feasible and viable, though there is some hesitation toward not kissing a child on the lips or sharing food and utensils.

This is the first study to look at women's attitudes toward each CMV prevention behavior individually. Previous studies have reported that women who are involved as research participants are generally willing to following prevention behavior guidelines. Preliminary evidence by Revello (Revello et al., 2015) reported that 80% of women enrolled in a CMV counseling study followed the recommended behaviors of handwashing, not kissing, and not sharing food or cups and utensils. Similarly, Adler (Adler et al., 2004) reported that women in his study felt able to make and sustain the necessary behavior changes, again, including handwashing, not kissing and not sharing, to prevent CMV transmission. Professional associations have been reluctant to support

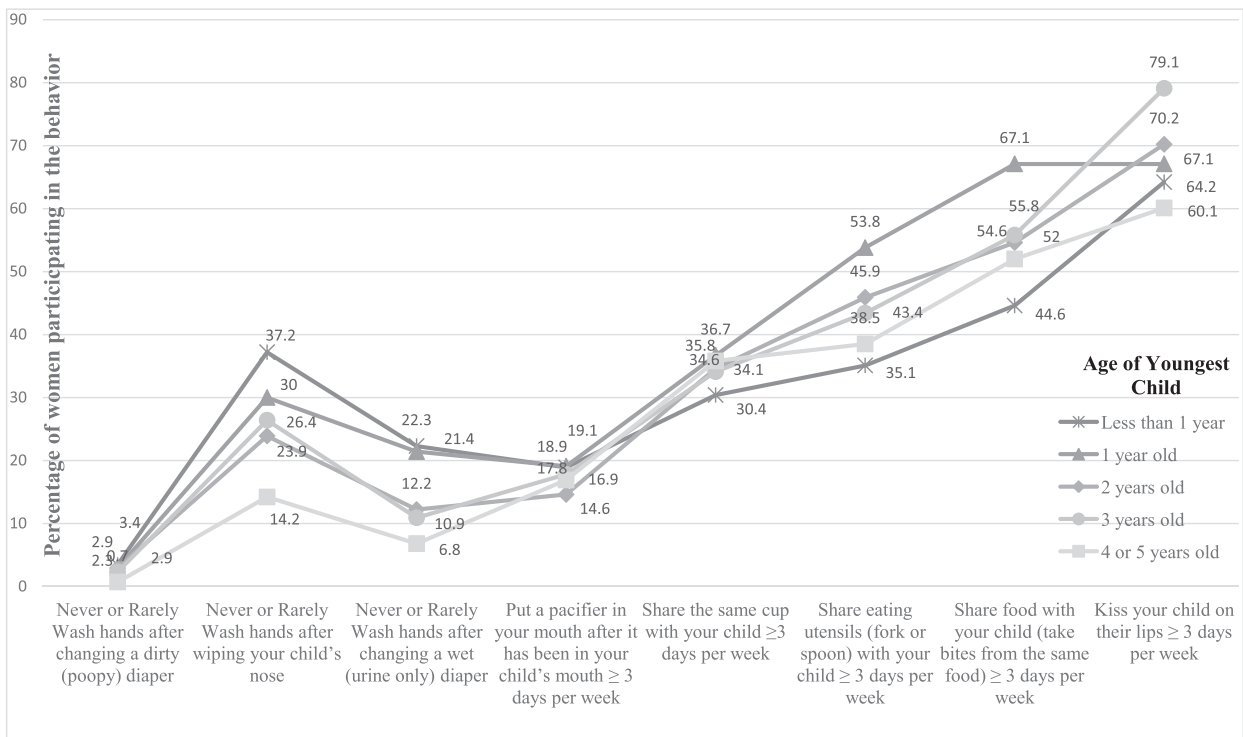


Fig. 3. Percentage of U.S. women participating in CMV risk behaviors by age of youngest child at home. Description: The percentage of respondents who reported they never or rarely participated in CMV prevention behaviors and the number of women who participated in CMV risk behaviors 3 or more times a week are stratified by the age of the youngest child at home.

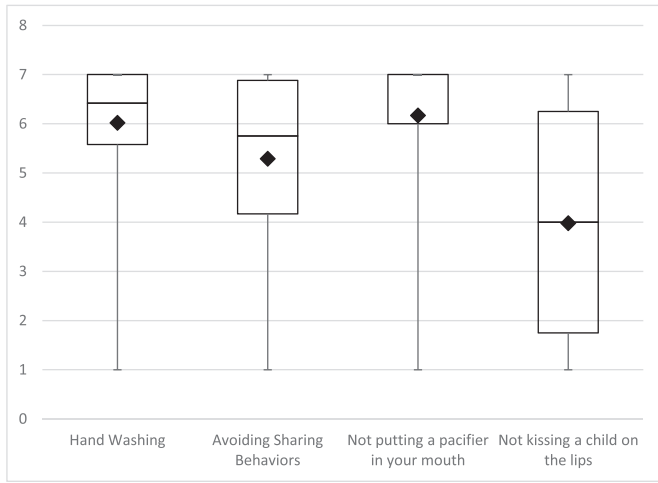


Fig. 4. U.S. women's attitudes toward CMV prevention behaviors. Description: Women's attitudes toward CMV prevention behaviors were evaluated using four seven-point semantic differential scales (impractical to practical, difficult to easy, inconvenient to convenient, and unrealistic to realistic). These scales were averaged to create the distributions. Box plots summarize the distribution of attitudes across the behaviors: median (diamond shape), interquartile range (25th and 75th percentiles), and range (minimum and maximum). Higher scores represent more positive attitudes toward the behavior or behavior group.

guidelines for behavioral guidelines beyond handwashing as they perceive that women will see them as burdensome and impractical (American College of Obstetricians and Gynecologists, 2015). The research by Revello and Adler, along with the present study, indicate that contrary to long-held perceptions, women are, in fact, amenable to following these behaviors.

Similar to past research, (Cannon et al., 2012) women in our sample were frequently engaging in sharing and kissing behaviors that result in direct CMV transmission. Women in our study indicated that *not* sharing food was somewhat inconvenient. Parental influence is a significant factor in children's eating behaviors (Daniels et al., 2009). One technique to encourage children to try new foods is modeling (Patrick & Nicklas, 2005). Modeling occurs when parents demonstrate taking a bite of food and then encourage a child to do the same. Modeling may

contribute to the high rates of parents sharing food and utensils with young children. Parents may perceive that it would be too difficult and inconvenient to introduce new foods without practicing modeling.

Of all the CMV prevention behaviors, women held the least positive attitudes toward *not* kissing a child on the lips. Kissing children is a common cultural practice to demonstrate affection between a parent and a child (Johnson & Hooper, 2004). In a study about the appropriateness of various affection behaviors only 20% of respondents felt that kissing on the lips was *not* appropriate. Furthermore, respondents indicated that the mean age at which kissing a child on the mouth should end was 5-years-old. Similarly, our results show that women with a child ages 4–5 years old reported kissing on the mouth least often signifying that over time, with the increase in child's age, the frequency of this practice decreases. Yet the saliva of young children carries the highest CMV viral loads (Cannon et al., 2014b) so kissing on the lips may substantially increase risk of infection.

Most CMV interventions have focused on improving hand hygiene (Harvey & Dennis, 2008). However, people are already doing those behaviors with a great level of consistency. The greatest gains in reducing CMV infection may be seen by encouraging women to *not* kiss their child on the lips and *not* share food or eating utensils. Even though women's attitudes toward these prevention behaviors are the least positive, they are perhaps the most important to encourage because it is a direct route of transmission and viral loads for CMV are highest in saliva (Cannon et al., 2014b). Because these behaviors are rooted in cultural tradition altering them may be challenging. However, we have seen shifts in other cultural norms related to maternal and child health, including putting an infant to sleep on its back (Adams et al., 2015) and placing children in car safety seats (Winston et al., 2004).

Regression models showed several predictors of positive attitudes toward CMV prevention behaviors. The one common predictor of women's positive attitudes across each of the CMV prevention behaviors was whether women felt that their risk of CMV infection would be reduced by practicing the behavior (i.e., response efficacy). We observed that a one-point increase in response efficacy was associated with a 0.48–0.69 point increase (depending on the behavior group) in positive attitudes toward avoiding the risk behaviors. In addition, predictors of positive attitudes toward *not* kissing a child on the lips were women's awareness of CMV, their past kissing behaviors, and having talked with a healthcare provider about CMV. Likewise, positive attitudes toward *not* sharing food or utensils were predicted by whether

Table 2
Prevalence of CMV risk behaviors among U.S. women by race/ethnicity and education.

Behavior	Respondent's race/ethnicity			P	Respondent's education			P
	White, non-Hispanic n = 611	Black, non-Hispanic n = 66	Other, non-Hispanic n = 163		High school graduate or less n = 177	Some college or associate's degree n = 324	College graduate or more n = 339	
Wash hands after changing a dirty (poopy) diaper								
Never/rarely	16 (2.6)	2 (3.0)	3 (1.8)	0.82	6 (3.4)	9 (2.8)	6 (1.8)	0.5
Wash hands after wiping your child's nose								
Never/rarely	180 (29.5)	12 (18.2)	30 (18.4)	0.005	38 (21.5)	103 (31.8)	81 (23.9)	0.01
Wash hands after changing a wet (urine only) diaper								
Never/rarely	104 (17.0)	11 (16.7)	12 (7.4)	0.008	21 (11.9)	57 (17.6)	49 (14.5)	0.21
Share the same cup with your child								
Everyday & 3–5 days per week	218 (35.7)	23 (34.8)	49 (30.1)	0.41	75 (42.4)	111 (34.3)	104 (31.7)	0.03
Share eating utensils (fork or spoon) with your child								
Everyday & 3–5 days per week	277 (45.3)	30 (45.5)	65 (39.9)	0.45	87 (49.2)	148 (45.7)	137 (40.4)	0.13
Share food with your child (take bites from the same food)								
Everyday & 3–5 days per week	353 (57.6)	37 (56.1)	79 (48.5)	0.11	105 (59.3)	180 (55.6)	183 (54.0)	0.51
Put a pacifier in your mouth after it has been in your child's mouth								
Everyday & 3–5 days per week	110 (18.0)	13 (19.7)	23 (14.1)	0.44	37 (20.9)	58 (17.9)	51 (15.0)	0.24
Kiss your child on their lips								
Everyday & 3–5 days per week	431 (70.5)	39 (59.1)	101 (62.0)	0.03	126 (71.2)	235 (72.5)	210 (62.0)	0.008

Table 3
Prevalence of CMV risk behaviors among U.S. women by annual household income.

	Respondent's annual household income				P
	Less than \$25,000 n = 118	\$25,000–\$49,999 n = 273	\$50,000–\$74,999 n = 234	\$75,000 or more n = 215	
Wash hands after changing a dirty (poopy) diaper Never/Rarely	<i>Insufficient data</i>	10 (3.66)	5 (2.14)	5 (2.33)	0.39
Wash hands after wiping your child's nose Never/Rarely	30 (25.4)	75 (27.5)	71 (30.3)	46 (21.4)	0.18
Wash hands after changing a wet (urine only) diaper Never/Rarely	17 (14.4)	47 (17.22)	37 (15.8)	26 (12.1)	0.46
Share the same cup with your child Everyday & 3–5 days per week	45 (38.1)	101 (37.0)	68 (29.1)	76 (35.4)	0.21
Share eating utensils (fork or spoon) with your child Everyday & 3–5 days per week	54 (45.8)	131 (48.0)	90 (38.5)	97 (45.1)	0.18
Share food with your child (take bites from the same food) Everyday & 3–5 days per week	68 (57.6)	156 (57.1)	119 (50.9)	125 (58.1)	0.37
Put a pacifier in your mouth after it has been in your child's mouth Everyday & 3–5 days per week	18 (15.3)	56 (20.5)	33 (14.1)	39 (18.1)	0.25
Kiss your child on their lips Everyday & 3–5 days per week	80 (67.8)	198 (72.5)	156 (66.7)	137 (63.7)	0.21

or not women were aware of CMV. The more positive attitudes associated with awareness may be because women understand the consequences of infection. This underscores the need for more communication about CMV, particularly messages that emphasize risk reduction as a result of behavioral action.

Though substantially fewer women reported that their healthcare provider had talked to them about CMV than was reported by Ross and colleagues (Ross et al., 2008) it was also an important predictor of attitudes toward CMV prevention behaviors. Low rates of providing information to expectant mothers about how to reduce risk is not limited to CMV (Krugman & Cumpsty-Fowler, 2015). However, healthcare providers are a critical partner with the public health sector in the efforts to increase CMV awareness and convey guidance for how to prevent infection because nearly two-thirds of women reported having a visit with an obstetrician/gynecologist within the last year (Ranji & Salganicoff, 2011). Providers often do not have the time to discuss all the factors that may influence a woman's pregnancy outcomes. Recognizing that current standards for prenatal care do not include routine CMV counseling for all women, providers, particularly obstetrician/gynecologists who routinely discuss prevention, may want to consider prioritizing counseling with women who are at highest risk for CMV infection. This would be women with young children at home and child care workers. Furthermore, given the advances in technology, there are alternative approaches to delivering CMV information that would not increase the burden on providers. Women are open to a variety of formats when receiving CMV information (Price et al., 2014) so considering email messages, links to online videos, brochures, or referral to websites could be considered.

5. Study limitations and strengths

This was a cross-sectional study with a large, national sample. As far as we know, it is one of the first papers to assess women's attitudes toward CMV prevention behaviors. However, these results should be considered with the following limitations in mind. The data were cross-sectional and collected from an online panel whose participants may not represent all women in the United States who are pregnant or thinking about becoming pregnant. Our sample's demographic data mirror other studies that have used national samples to assess CMV awareness and knowledge (Price et al., 2014; Cannon et al., 2014b). The percent of women with a college degree or greater is higher than the US estimate of 30% (US Census Bureau, 2014). The median US household income is \$53,000 (US) (US Census Bureau, 2015) and though we cannot directly compare with this study's income categories, the distribution indicates that our sample maybe be more wealthy. Because this is self-report data there may be bias due to recall and social desirability. Women may report that they do these behaviors more frequently than actually occurs in practice. Direct monitoring of individual behaviors is challenging, if not impossible. Studies among health care workers have shown self-report of handwashing to be highly correlated with objective measures suggesting that it is possible to accurately self-report some hygiene behaviors (Moret et al., 2004). Next, women may have failed to recall that they did in fact receive CMV prevention messaging from their provider. Lastly, the semantic differential scale was developed by the researchers. Measures of reliability indicated high internal consistency of items, yet validity evidence needs to be established.

Table 4
Attitudes of U.S. women's age 18–40 who are pregnant or planning a pregnancy toward CMV prevention behaviors.

CMV prevention behavior ^a	Impractical to practical	Inconvenient to convenient	Difficult to easy	Unrealistic to realistic
	Mean (95% confidence interval)			
Wash my hands after changing my child's dirty (poopy) diaper	6.46 (6.37–6.54)	5.69 (5.57–5.80)	6.35 (6.26–6.44)	6.44 (6.36–6.52)
Wash my hands after changing my child's wet diaper	6.18 (6.09–6.27)	5.59 (5.47–5.71)	6.30 (6.22–6.39)	6.16 (6.07–6.26)
Wash my hands after wiping my child's nose	5.90 (5.80–6.01)	5.30 (5.18–5.43)	6.07 (5.98–6.17)	5.80 (5.69–5.90)
NOT Share the same cup with my child	5.57 (5.45–5.70)	5.30 (5.17–5.43)	5.51 (5.39–5.64)	5.45 (5.33–5.58)
NOT Share eating utensils with my child	5.50 (5.37–5.62)	5.24 (5.11–5.37)	5.46 (5.33–5.58)	5.47 (5.35–5.60)
NOT share food with my child	5.17 (5.04–5.30)	4.83 (4.69–4.97)	5.00 (4.87–5.14)	5.02 (4.89–5.16)
NOT put a pacifier in my mouth after it's been in my child's mouth	6.22 (6.12–6.31)	6.01 (5.90–6.13)	6.23 (6.12–6.33)	6.21 (6.11–6.31)
Not kiss my child on their lips	4.13 (3.97–4.29)	4.13 (3.97–4.29)	3.72 (3.56–3.89)	3.92 (3.76–4.09)

^a Women's attitudes toward CMV prevention behaviors were evaluated using four seven-point semantic differential scales: impractical (1) to practical (7), difficult (1) to easy (7), inconvenient (1) to convenient (7), and unrealistic (1) to realistic (7). Higher mean scores indicate more positive attitudes.

Table 5
Multiple linear regression models, identifying factors associated with U.S. women's attitudes toward CMV prevention behaviors.

Variable	Attitude toward hand washing behaviors ^{a,b}	Attitude toward avoiding sharing behaviors ^{c,d}	Attitude toward not kissing a child on the lips ^{e,f}	Attitude toward not putting a pacifier in the mouth ^{g,h}
Model r ²	0.22	0.35	0.48	0.28
Variable	b (95% confidence interval) ⁱ	b (95% confidence interval) ⁱ	b (95% confidence interval) ⁱ	b (95% confidence interval) ⁱ
Intercept	2.31 (1.76–2.86)	−0.9 (−0.78–0.60)	0.03 (−0.86–0.91)	0.97 (0.30–1.64)
Education				
Less than high school graduate or less	0.21 (0.02–0.40)			
Some college or associate's degree	0.18 (0.02–0.34)			
College graduate/bachelor's degree or more	ref			
Pre-survey frequency of washing hands after wiping child's nose	0.19 (0.11–0.27)			
Pre-survey frequency of washing hands after changing a wet diaper	0.2 (0.12–0.28)			
Belief that washing hands would be effective in preventing CMV infection	0.48 (0.36–0.59)			
Respondent's age in years			−0.03 (−0.05–0.005)	
Race & ethnicity				
Other race, non-Hispanic		0.29 (0.12)	0.64 (0.35–0.93)	
Black, non-Hispanic		0.33 (0.17)	0.45 (0.03–0.88)	
White, non-Hispanic		Ref	Ref	
Age of youngest child at home				
4 or 5 years of age		0.55 (0.16)	0.41 (0.03–0.79)	
3 years of age		0.60 (0.16)	0.49 (0.09–0.89)	
2 years of age		0.27 (−0.16–0.56)	0.07 (−0.28–0.43)	
1 year of age		0.19 (−0.10–0.48)	0.04 (−0.31–0.39)	
Less than 1 year of age		Ref	Ref	
Aware of CMV				
Yes		0.45 (0.20–0.71)	0.54 (0.18–0.91)	
No		Ref	Ref	
Perceived severity of CMV		0.09 (−0.01–0.18)		0.09 (0.01–0.18)
Pre-survey frequency of sharing a cup with a child ^j		0.11 (0.02–0.20)		
Pre-survey frequency of sharing utensils with a child ^j		0.21 (0.11–0.32)		
Pre-survey frequency of sharing food with a child ^j		0.15 (0.05–0.26)		
Belief that Not sharing food, cups or utensils with a child would be effective in preventing CMV infection		0.69 (0.57–0.82)		
Talked to a Healthcare Provider about CMV				
Yes			0.83 (0.29–1.38)	
No			Ref	
Perceived susceptibility to CMV			0.09 (0.01–0.18)	
Pre-Survey Frequency of Kissing Child on Lips ^j			0.84 (0.76–0.92)	
Belief that NOT kissing a child on the lips would be effective in preventing CMV infection			0.53 (0.42–0.64)	
Income				
\$75,000 or more				0.58 (0.30–0.86)
\$50,000–\$74,999				0.40 (0.13–0.68)
\$25,000–\$49,999				0.50 (0.23–0.77)
Less than \$25,000				ref
Pre-survey frequency of putting a pacifier in your mouth after it has been in a child's mouth ^j				0.35 (0.28–0.41)
Belief that NOT putting a pacifier in your mouth after it has been in a child's mouth would be effective in preventing CMV infection.				0.62 (0.50–0.74)

^a Attitude toward hand hygiene measured by the combined semantic differential scales for each of the three hand hygiene behaviors: washing hands after changing diapers (poopy & wet only) and washing hands after wiping a child's nose.

^b This model adjusted for respondent's education, pre-survey frequency of washing hands after wiping a child's nose, pre-survey frequency of washing hands after changing a wet diaper and respondent's belief that washing hands after changing a dirty diaper, wet diaper or wiping a child's nose would be effective in preventing CMV infection.

^c Attitude toward avoiding sharing behaviors measured by the combined semantic differential scales for each of the 3 sharing behaviors: sharing a cup, sharing utensils and sharing food with a child.

^d Model adjusted for respondent's race/ethnicity, age of the youngest child at home, CMV awareness, perceived severity of CMV, pre-survey frequency of sharing a cup, sharing food and sharing utensils, and respondent's belief that NOT sharing food, cups, or utensils would be effective in preventing CMV infection.

^e Attitude toward avoiding kissing a child on the lips measured by the combined semantic differential scales for this behavior.

^f Model adjusted for respondent's race/ethnicity, age of the youngest child at home, awareness of CMV, whether the respondent had ever talked to a healthcare provider about CMV, respondent's age in years, perceived susceptibility to CMV, pre-survey frequency of kissing a child on the lips, and respondent's belief that NOT kissing a child on the lips would be effective in preventing CMV infection.

^g Attitude toward not putting a pacifier in the mouth measured by the combined semantic differential scales for this behavior.

^h Model adjusted for annual household income, perceived severity of CMV, pre-survey frequency of putting a pacifier in your mouth after it has been in a child's mouth, and respondent's belief that NOT putting a pacifier in her mouth would be effective in preventing CMV infection.

ⁱ Models were constructed using backward elimination with a threshold of alpha = 0.10. Covariates without coefficients were not significant in the models.

^j Pre-survey frequency of sharing food, cups, or utensils with a child, kissing a child on the lips, and putting a pacifier in your mouth after it has been in a child's mouth reverse coded so that a positive coefficient indicates that lower frequency of the risk behavior is associated with more positive attitudes toward the prevention behavior.

6. Conclusions

This study revealed that women have relatively positive attitudes toward practicing CMV prevention behaviors. Positive attitudes were

predicted, in part, by CMV awareness and having a healthcare provider talk to them about CMV. The responsibility for increasing women's awareness of CMV cannot be left to health care providers alone. A collaborative effort between healthcare and public health is necessary

to increase awareness. Public health communication campaigns in addition to provider counseling could be useful. In addition, ensuring that CMV information is available on pregnancy websites and reference books is important (Thackeray et al., 2014). Further research regarding best practices for how to frame and communicate CMV prevention messages, particularly about the efficacy of these behaviors to reduce risk, and the most effective methods for delivering this information in healthcare and public health settings is needed.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare there is no conflict of interest.

Acknowledgements

The authors acknowledge Ms. Emily Christensen for her assistance with study design and discussion of study results.

References

- Adams, S.M., Ward, C.E., Garcia, K.L., 2015. Sudden infant death syndrome. *Am. Fam. Physician* 91 (11).
- Adler, S.P., Finney, J.W., Manganello, M., Best, A.M., 2004. Prevention of child-to-mother transmission of cytomegalovirus among pregnant women. *J. Pediatr.* 145, 485–491.
- American College of Obstetricians and Gynecologists, 2015. Practice bulletin no. 151: cytomegalovirus, parvovirus B19, varicella zoster, and toxoplasmosis in pregnancy. *Obstet. Gynecol.* 125 (6), 1510–1525. <http://dx.doi.org/10.1097/01.AOG.0000466430.19823.53>.
- Block, L.G., Keller, P.A., 1995. When to accentuate the negative: the effects of perceived efficacy and message framing on intentions to perform a health-related behavior. *J. Mark. Res.* 192–203.
- Boppana, S.B., 2006. Cytomegalovirus. In: Hutto, C. (Ed.), *Congenital and Perinatal Infections: A Concise Guide to Diagnosis*. Humana Press, Totowa, New Jersey, pp. 73–86 <http://dx.doi.org/10.1385/1592599656>.
- Cannon, M.J., Davis, K.F., 2005. Washing our hands of the congenital cytomegalovirus disease epidemic. *BMC Public Health* 5 (70). <http://dx.doi.org/10.1186/1471-2458-5-70>.
- Cannon, M.J., Griffiths, P.D., Aston, V., Rawlinson, W.D., 2014a. Universal newborn screening for congenital CMV infection: what is the evidence of potential benefit? *Rev. Med. Virol.* 24 (5), 291–307.
- Cannon, M.J., Stowell, J.D., Clark, R., et al., 2014b. Repeated measures study of weekly and daily cytomegalovirus shedding patterns in saliva and urine of healthy cytomegalovirus-seropositive children. *BMC Infect. Dis.* 13, 569.
- Cannon, M.J., Westbrook, K., Devis, D., Schleiss, M.R., Thackeray, R., Pass, R.F., 2012. Awareness of and behaviors related to child-to-mother transmission of cytomegalovirus. *Prev. Med.* 54 (5), 351–357.
- Centers for Disease Control and Prevention. Cytomegalovirus (CMV) and congenital CMV infection. Centers for Disease Control and Prevention website. <http://www.cdc.gov/cmV/overview.html>. Updated 2016. Accessed August, 26, 2016.
- Daniels, L.A., Magarey, A., Battistutta, D., et al., 2009. The NOURISH randomised control trial: Positive feeding practices and food preferences in early childhood - a primary prevention program for childhood obesity. *BMC Public Health* 9 387-2458-9-387.
- Dollard, S.C., Grosse, S.D., Ross, D.S., 2007. New estimates of the prevalence of neurological and sensory sequelae and mortality associated with congenital cytomegalovirus infection. *Rev. Med. Virol.* 17 (5), 355–363.
- Godin, G., Kok, G., 1996. The theory of planned behavior: a review of its applications to health-related behaviors. *Am. J. Health Promot.* 11 (2), 87–98.
- Grosse, S.D., Ross, D.S., Dollard, S.C., 2008. Congenital cytomegalovirus (CMV) infection as a cause of permanent bilateral hearing loss: a quantitative assessment. *J. Clin. Virol.* 41 (2), 57–62.
- Harrison, G.J., 2015. Current controversies in diagnosis, management, and prevention of congenital cytomegalovirus: updates for the pediatric practitioner. *Pediatr. Ann.* 44 (5), e115–e125.
- Harvey, J., Dennis, C., 2008. Hygiene interventions for prevention of cytomegalovirus infection among childbearing women: systematic review. *J. Adv. Nurs.* 63 (5), 440–450.
- Hyde, T.B., Schmid, D.S., Cannon, M.J., 2010. Cytomegalovirus seroconversion rates and risk factors: implications for congenital CMV. *Rev. Med. Virol.* 20 (5), 311–326.
- Jeon, J., Victor, M., Adler, S.P., et al., 2006. Knowledge and awareness of congenital cytomegalovirus among women. *Infect. Dis. Obstet. Gynecol.* 1–7 <http://dx.doi.org/10.1155/IDOG/2006/80383>.
- Johnson, T.C., Hooper, R.L., 2004. Boundaries and family practices: implications for assessing child abuse. *J. Child Sex Abuse.* 12 (3–4), 103–125.
- Kimberlin, D.W., Brady, M.T., Jackson, M.A., Long, S.S. (Eds.), 2015. *Red Book. 2015 Report of the Committee on Infectious Diseases*. American Academy of Pediatrics, Elk Grove Village, IL.
- Krugman, S.D., Cumpsty-Fowler, C.J., 2015. Parental advice: given perhaps, but not received. *Pediatrics* 136 (2), e490–1.
- Mazza, D., Chapman, A., Michie, S., 2013. Barriers to the implementation of preconception care guidelines as perceived by general practitioners: a qualitative study. *BMC Health Serv. Res.* 13, 1.
- Moret, L., Tequi, B., Lombraill, P., 2004. Should self-assessment methods be used to measure compliance with handwashing recommendations? A study carried out in a French university hospital. *Am. J. Infect. Control* 32 (7), 384–390.
- Morgan, M.A., Anderson, B.L., Lawrence, H., Schulkin, J., 2012. Well-woman care among obstetrician-gynecologists: opportunity for preconception care. *J. of Maternal-Fetal & Neonatal Med.* 25 (6), 595–599.
- Nan, X., Xie, B., Madden, K., 2012. Acceptability of the H1N1 vaccine among older adults: the interplay of message framing and perceived vaccine safety and efficacy. *Health Commun.* 27 (6), 559–568.
- Patrick, H., Nicklas, T.A., 2005. A review of family and social determinants of children's eating patterns and diet quality. *J. Am. Coll. Nutr.* 24 (2), 83–92.
- Pereboom, M.T., Mannien, J., Spelten, E.R., Schellevis, F.G., Hutton, E.K., 2013. Observational study to assess pregnant women's knowledge and behaviour to prevent toxoplasmosis, listeriosis and cytomegalovirus. *BMC Pregnancy Childbirth.* 13, 98.
- Plotkin, S., 2015. The history of vaccination against cytomegalovirus. *Med Microbiol Immunol (Berl.)* 204 (3), 247–254.
- Price, S.M., Bonilla, E., Zador, P., Levis, D.M., Kilgo, C.L., Cannon, M.J., 2014. Educating women about congenital cytomegalovirus: assessment of health education materials through a web-based survey Women's has an apostrophe. *BMC Women's Health.* 14 (1), 144.
- Ranji, U., Salganicoff, A., 2011. Women's health care chartbook. Key findings from the May 2011 Kaiser Women's Health Survey. <https://kaiserfamilyfoundation.files.wordpress.com/2013/01/8164.pdf>.
- Revello, M.G., Tibaldi, C., Masuelli, G., et al., 2015. Prevention of primary cytomegalovirus infection in pregnancy. *EBioMedicine.* 2 (9), 1205–1210.
- Ross, D.A., Victor, M., Sumartojo, E., Cannon, M.J., 2008. Women's knowledge of congenital cytomegalovirus: results from the 2005 HealthStyles survey. *J. Women's Health* 17 (5), 849–858.
- Ross, D.S., Rasmussen, S.A., Cannon, M.J., et al., 2009. Obstetrician/gynecologists' knowledge, attitudes, and practices regarding prevention of infections in pregnancy. *J. Women's Health* 18 (8), 1187–1193.
- Schleiss, M.R., 2008. Congenital cytomegalovirus infection: update on management strategies. *Curr. Treat. Options Neurol.* 10 (3), 186–192.
- Taber, J.M., Aspinwall, L.G., 2015. Framing recommendations to promote prevention behaviors among people at high risk: a simulation study of responses to melanoma genetic test reporting. *J. Genet. Couns.* 24 (5), 1–12.
- Thackeray, R., Wright, A., Chipman, K., 2014. Congenital cytomegalovirus reference material: a content analysis of coverage and accuracy. *Matern. Child Health J.* 18 (3), 584–591.
- US Census Bureau. American Fact Finder. Sex by educational attainment for the population 25 years and over. Retrieved from US Census Bureau website. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_1YR_B15002&prodType=table. Updated 2014. Accessed August 26, 2016.
- US Census Bureau. Quick Facts. United States. Retrieved from US Census Bureau website. <https://www.census.gov/quickfacts/table/PST045215/00>. Updated 2015. Accessed August 26, 2016.
- Vauloup-Fellous, C., Picone, O., Cordier, A., et al., 2009. Does hygiene counseling have an impact on the rate of CMV primary infection during pregnancy?: Results of a 3-year prospective study in a French hospital. *J. Clin. Virol.* 46 Supplement 4, S49–S53.
- Willame, A., Blanchard-Rohner, G., Combescure, C., Irion, O., Posfay-Barbe, K., 2015. Martinez de Tejada B. Awareness of cytomegalovirus infection among pregnant women in Geneva, Switzerland: a cross-sectional study. *Int. J. Environ. Res. Public Health* 12 (12), 15285–15297.
- Winston, F.K., Chen, I.G., Elliott, M.R., Arbogast, K.B., Durbin, D.R., 2004. Recent trends in child restraint practices in the United States. *Pediatrics* 113 (5), e458–e464.
- Witte, K., 1994. Fear control and danger control: a test of the extended parallel process model (EPPM). *Commun. Monogr.* 61 (2), 113–134.
- Zolotor, A.J., Carlough, M.C., 2014. Update on prenatal care. *Am. Fam. Physician* 89 (3), 199–208.