Short communication

Adverse reproductive effects of beer drinking

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Abstract

This short communication represents a systematic review of the literature about beer drinking during gestation. A Medline search was undertaken of articles based on the criterion that beer and pregnancy were in the abstract and central to the article. Manuscripts were to be published in English in peer review medical journals from 1981 to 2006. Beer is a commonly consumed alcoholic beverage among reproductive-age adults. Beer drinking males have an increased risk of contributing to pregnancy waste. Women consume beer before and after pregnancy recognition. Binge drinking appears to be a common drinking behavior, and those who binge drink have an increased risk of impaired fetal growth and offspring behavior. Beer consumption by lactating women might temporarily impair motor function of nursing infants. Evidence for potentiation of beer effects by congeners and by simultaneous use of substances of abuse is inconclusive.

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1. Introduction

Research on beverage-specific prototypes is important to characterize individuals who consume a major percentage of alcohol from a particular beverage. Such research on the epidemiology of consumption helps identify population groups at risk for specific alcohol-related problems. Beer is a popular alcoholic beverage consumed by reproductive-age women because of its relatively low cost and ease of availability. Furthermore, beer is perceived by some women as being relatively safe before or after conception because of its lower alcohol content.

This short communication represents a systematic review of the medical literature on reproductive effects from beer drinking. A Medline search was undertaken to locate articles containing beer and pregnancy being mentioned in the abstract and being central to the text. Manuscripts were selected if published in English in peer-reviewed medical journals spanning a recent 26-year period (1981–2006).

2. Patterns in beer drinking

As a commonly consumed beverage worldwide, beer should not be ignored in preconception and prenatal screening. In a study of 2913 antepartum gravidas in Cleveland, OH, Sokol et al. [1] reported in 1981 that 57% of the women who reportedly drank while pregnant preferred beer to other forms of alcohol. About 52% of pregnant participants in a Swedish study drank beer at least once weekly, with one to six bottles or cans per occasion [2]. Another investigation in South Africa revealed that women who continued to drink after pregnancy awareness preferred beer, also often in a binge drinking manner (≥5 drinking units per drinking day) during weekends [3]. In a 1-year cohort of 872 Swedish nulliparas, Dejin-Karlsson et al. noted that younger women or those with fewer years of education tended to continue drinking alcohol during pregnancy if it was beer and in a binge manner [4]. Our reported experience with hazardous pregnant drinkers revealed beer to be the beverage of choice before and after pregnancy recognition [5].

Graves and Kaskutas from the Alcohol Research Group discovered that more than one-fourth of their surveyed Native American (n = 70) and African-American (n = 129) urban pregnant patients believed that beer and wine were safer than other kinds of alcoholic drinks [6]. The alcoholic beverage most often
used, adjusted for other beverages consumed, was beer, followed in order by spirits, wine coolers, wine, and fortified wine. Women who drank daily were more likely to choose beer and wine products with a higher alcohol content.

A similar study by the same research group, assessed exposure and reactions to health warnings intended to encourage abstinence during pregnancy [7]. Most of the 321 multiethnic women from urban California areas who drank malt liquor (commonly equated with beer) reported having larger than standard drinks, and daily drinkers had the highest levels of reporting error. When drink size was considered in the calculation of alcohol volume, average daily volume of consumption during pregnancy increased to the fetal alcohol syndrome risk level (average daily volume \( \geq 1 \)) in the overall sample and among the African American and white subjects.

Most women cease drinking or significantly curtail their habit once pregnancy is confirmed, by which time the embryo has already been exposed to high levels of alcohol [8]. Those who continue to drink during pregnancy tend to consume beer [2,5,9]. Although the amount of beer is wide ranging, Halmesmaki et al. reported that 90% of subjects drank two or fewer drinks per week [2]. Hazardous drinking is identified on alcohol surveys as frequent or binge drinking habits with related consequences. Rayburn et al. examined the prevalence of beer consumption among hazardous drinkers in a predominantly Hispanic pregnant patient population [5]. This prospective clinic-based cohort study involved 203 women surveyed during their first prenatal visit and throughout gestation who met criteria for hazardous drinking, met study eligibility criteria, and completed the interviews. Beer was consumed most often (74.4%) and in greater quantities than wine \((p < 0.05)\) or liquor \((p < 0.01)\). Beer continued to be consumed by 52.3% women after pregnancy recognition. Although abstinence for prolonged periods was common during pregnancy, beer was consumed more than wine and liquor per drinking episode (2.7 drinking units per drinking day versus 0.9 drinking units per drinking day; \(p = 0.002\)) indicating a binging pattern. Of those who continued to drink beer, very few switched either to a light beer (2.9%) or to a nonalcoholic beer (0.5%).

### 3. Reproductive health effects

#### 3.1. Fertility

Any prolongation in conceiving is not beer-specific but can be a response to a high intake of alcohol in general. Juhl et al. examined the association between beer, wine, and spirits and the waiting time to conception [10]. Self-reported data were used for 29,844 pregnant women, recruited to the Danish National Birth Cohort in 1997–2000. The waiting time to pregnancy was neither shorter nor longer with beer drinking.

Modifying beer drinking habits may improve success rates with assisted reproductive technology. Klomoff-Cohen et al. conducted the first study to report an association between parental alcohol use and reproductive endpoints of in vitro fertilization (IVF) and gamete intralhallopin transfer (GIFT) [11]. This multicenter prospective study in southern California involved 221 couples with female infertility. Estimates were not adjusted for other factors. Female alcohol consumption consisted primarily of wine rather than beer, and was associated with: (1) a 13% decrease in the number of oocytes aspirated (adjusted 95% confidence interval [CI]: −2% to −23%, for one additional drink per day, 1 year before the IVF or GIFT attempt); (2) an increase in risk of not achieving pregnancy by 2.9 times (1.0–8.2, 1 month prior); and (3) an increase in risk of spontaneous abortion by 2.2 times (1.1–4.5, 1 week before the procedure). Beer was the beverage of choice for men. For male partners, one additional can of beer per day increased the risk of not achieving a live birth by 2.3 times (1.1–4.8) to 8.3 times (1.8–38.0), depending on the time before or during IVF or GIFT. This outcome may result from increased risk of abortion by 2.7–38.0 times for men who drank within 1 month before and during IVF and GIFT.

#### 3.2. Pregnancy

##### 3.2.1. Human studies

A safe threshold for alcohol intake in general and for beer in particular during pregnancy remains undetermined. No specific birth defect(s) attributable to beer was identified in the literature. Although some studies indicate that fetal malformations can result from consuming as few as one to two drinks per day, the effects of binge drinking are obscured by computing a daily average of alcohol consumption. Binge drinking is particularly common with the consumption of beer rather than wine or distilled spirits [12]. The National Survey on Drug Use and Health reported that 4.1% of pregnant women binge drank during the prior month [8]. Maternal consequences of binge drinking include unintentional injuries, exposure to domestic violence, unprotected and unplanned sexual intercourse, and sexually transmitted diseases [12,13]. This pattern is also associated with unplanned pregnancy and with continued drinking during gestation.

An analysis of the beverage consumed suggests that beer consumption is associated with a higher risk fetal outcome. Women with spontaneous abortions or stillbirths drank more beer than those with live births [14]. Increased risks of stillbirths and lower body and placental weights for heavier drinkers appear to be due to beer consumption, despite the lower average amount of ethanol consumed by beer rather than wine drinkers [15]. No human studies were located to find gender-specific changes in body weights of offspring after in utero beer exposure.

Fetuses exposed to binge drinking are at greater risk of cognitive deficits, delinquent behavior at age 7 years, and IQ scores in the mentally retarded range [13,16,17]. Jacobson et al. found that 80% of functionally impaired infants were born to women who drank more than five drinks per occasion, on several occasions weekly [17]. After adjustment for the effect of smoking, social class, mother’s size, and other confounding factors, however, an alcohol intake of more than 12 standard drinks per week was significantly related only to a shorter gestational age (by 2.0 weeks; \(p < 0.001\)) and to a lower Apgar score at 5 min (by 0.2 points; \(p < 0.05\)). Alcohol intake in the range of 100–119 g/week was significantly related to a smaller head circumference (by 12 mm; \(p < 0.05\)). A weekly average of alcohol consumption must be
interpreted with caution. High blood alcohol levels reached on one or two occasions in a week during embryogenesis might have serious developmental consequences than an equal lower amount consumed daily.

Certain limitations inherent to studies on beer drinking by women during pregnancy are noteworthy. Study populations may not be representative, since many are predominantly poor or with lower incomes. Most surveys rely on pregnant drinkers to quantify alcohol consumption, and self-reported beer consumption is often underestimated [18]. Many women drink beer with other alcoholic beverages before and after pregnancy awareness [5]. Furthermore, beer is often consumed with other substances such as cigarettes and marijuana [5]. Gender-specific responses from in utero beer exposure were not found in human studies.

Alcohol and its metabolites in beer are eliminated rapidly, making them insensitive as biomarkers of chronic or intermittent exposure [19]. Other biomarkers of exposure are not very sensitive or specific for risky levels of any alcohol use in pregnancy, beer or otherwise. The literature is too sparse to compare with nonalcoholic beer drinkers for speculating on potentiating effects of congeners in beer. Hops refers to the female flowers (strobiles) of a vine (Humulus lupulus) used to flavor beer. Any effect of hops may be due to 8-prenylalcohol, a phytoestrogen that is much more potent than most phytoestrogens, although it is far weaker than estradiol [20]. What effect, if any, from fetal exposure to 8-prenylnaringenin is unknown.

3.2.2. Animal studies

Few experimental data exist about the effect of preconceptional and intragestational ethanol intake upon ovarian structure and function. The influence of acute intoxication with beer on the background of chronic ethanol intake upon ovarian morphology of various follicular developmental stages was studied by Sandor and Muresan on gestational day 4 (mice) and day 5 (rats) [21]. Compared with control animals, mice that consumed beer chronically and supplemented with acute intoxication had a significantly diminished percentage of antral and mature follicles. The clinical application of this finding is unclear.

Pregnancy outcomes after large daily doses of beer were reported in pregnant rats. Effects of beer were compared with those of wine, whiskey, and ethanol by Abel et al. [22]. Pregnant rats were intubated twice daily throughout gestation with the equivalent of 3 g/kg of alcohol being delivered as beer, wine, whiskey, or 95% ethanol. Control animals received a vehicle. All animals were pair-fed to those receiving ethanol. Offspring, removed from their biological mothers immediately following birth, were nursed by non-beer treated mothers. Pups in each of the four alcohol-treated groups weighed significantly less than the animals in the control group at birth and at 22 days of age. Performances on a Rotarod task at 17 days were significantly worse, with differences among the four alcohol-treated groups being indistinguishable for each of these measures. Despite limitations with the Rotarod task in detecting all kinds of behavior alterations from exposure to different alcohol beverages, their results argue against congeners in alcohol beverages potentiating adverse effects on embryonic/fetal development in rats.

The largest experience with beer research in pregnant rodents was by the team of Lancaster and Raheem [23] and Lancaster and Spiegel [24–26]. Their method of voluntary beer drinking by gravid rats (≥9.0 g/(kg day)) was designed to identify subtle consequences of maternal beer drinking. The dams were assigned either to beer drinking or to one of two control groups (nonalcoholic beer, no beer). All animals were given a standard laboratory diet and water ad libitum, while beer-exposed dams were provided ad libitum access to beer for 21 days before mating and throughout gestation. At birth, there were no differences between the tree groups in body weights or brain weights of the offspring [23]. At day 29 after birth, the whole brains were dissected into three areas: cerebrum, cerebellum and brainstem. Results showed a decreased concentration of myelin protein in the brainstems of female offspring exposed to beer during gestation [24].

In a similarly designed study, gravid rats gained more weight when drinking beer rather than nonalcoholic beer [24,25]. Significant hypoglycemia was observed in newborn male offspring exposed to beer [25]. At 20 days of age, all animals responded normally to glucose tolerance tests. At that time, liver weights of offspring of beer drinkers (alcoholic and nonalcoholic) were increased, and pancreas weights of alcoholic beer drinkers were increased. At 65 days of age, body weights were low of male offspring of alcoholic beer drinkers. These results indicate gender differences of offspring exposed to maternal beer drinking, and suggest that some of the observed alterations in development may be due to components in beer other than to alcohol alone.

In another study of voluntary beer drinking, female rats drank 9.5 g/kg of beer per day (pregestation) and 9.0 g/kg per day (gestation) [24]. Peak blood alcohol levels of dams were 193 mg/dL (pregestation) and 157 mg/dL (gestation). Body weights of male and female offspring of beer drinkers were greater than controls. Urinary pH levels were abnormally low at birth, and thymus/body weight ratios were high at birth. Abnormal spleen/body and heart/body ratios were observed in 15- and 29-day-old female offspring of beer drinkers. No hyperactivity or developmental delays were observed. Male offspring of dams in the beer group were hypoactive on a few days of testing. Male and female offspring of beer drinking dams performed better than either control group on some tests.

The sensitivity of rat offspring to ethanol and preference for beer were investigated by Lancaster and Spiegel [26]. Offspring exposed to maternal voluntary beer drinking had long-term alterations in sensitivity to ethanol as adults, although rates of ethanol metabolism were unaffected. Male offspring were delayed in maintaining baseline body temperature at 29 days and were tolerant to the hypothermic effects of ethanol at 29 and 85 days. Female offspring demonstrated a prolonged time to respond to pain and temperature change, and were tolerant to the effects of ethanol on motor coordination at those times. Although a preference for beer was not affected by maternal beer drinking, the pattern of fluid intake by exposed offspring differed from controls.
3.3. Lactation

Traditional wisdom claims that moderate beer consumption may be beneficial for initiation of breastfeeding and enhancement of breastfeeding. Beer can stimulate prolactin secretion which may enhance lactogenesis both in nonlactating humans and in experimental animals [27]. The component in beer responsible for the effect on prolactin secretion is not the alcohol content but apparently a polysaccharide from barley, which explains how its effect on prolactin can also be induced by nonalcoholic beer. It is conceivable that the relaxing effects of alcohol and the components of hops might also have beneficial effects on lactogenesis in some women, but there is no hard evidence for causal effects.

It appears prudent to not advocate regular use of alcoholic drinks during lactation. Adverse effects of an occasional alcoholic drink during lactation have been documented. Mennella and Beauchamp [28] reported that beer consumption by lactating women alters the taste of their milk and affects the short-term behavior of their infants. Those infants consumed less milk shortly after their mothers drank beer, regardless of the number of breastfeeding. Despite this, the mothers reported milk letdown while nursing, and believed that their infants ingested a sufficient quantity of milk.

Little et al. reported on a study of the relationship between child development at age 1 year and postnatal alcohol intake through breastfeeding [29]. The mothers were 400 primarily white, middle-class, educated women who were members of a health maintenance organization. An estimate was made of each infant’s total exposure to alcohol through breast milk, based on maternal intake and the number of days of breastfeeding for each month. The findings were controlled for levels of maternal drinking during pregnancy and postpartum, smoking, drug use, and other possibly confounding variables. Scores on the Bayley Mental Development Index at age 1 year did not correlate with infant alcohol exposure, but motor development, as measured by the Bayley Psychomotor Development Index, showed a negative correlation with total alcohol consumed by the infant.

4. Summary and conclusions

Beer is a commonly chosen and occasionally heavily consumed alcoholic beverage by reproductive-age women. Lower cost, easy availability, and a perception by many as being less harmful favors this alcoholic beverage, even after pregnancy awareness. Drinking beer does not shorten or lengthen the time until conception, yet reducing beer habits may increase assisted reproductive technology success. Routine prenatal questioning should focus on beer drinking patterns. Reliance on standard drink sizes can result in significant underreporting of consumption. Inquiring about drink size and number per drinking day is, therefore, recommended since binge drinking is more common when beer is consumed.

Counseling about specific hazards of beer drinking during pregnancy is unavailable. Although evidence is inconclusive about effects from social drinking on fetal growth and neurobehavior development, it is encouraged that a pregnant woman preferably cease all beer consumption and, if necessary, be referred to a treatment program. A brief alcohol intervention during the initial prenatal visit should be accompanied with literature, such as a brochure published by the National Institute on Alcohol Abuse and Alcoholism, about the hazards of continued drinking. Drinking beer by nursing women may affect qualities of milk and short-term behavior of exposed infants.

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