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MiniReview

Alcohol and Breastfeeding

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Abstract: While the harmful effects of alcohol during pregnancy are well-established, the consequences of alcohol intake during lactation have been far less examined. We reviewed available data on the prevalence of alcohol intake during lactation, the influence of alcohol on breastfeeding, the pharmacokinetics of alcohol in lactating women and nursing infants and the effects of alcohol intake on nursing infants. A systematic search was performed in PubMed from origin to May 2013, and 41 publications were included in the review. Approximately half of all lactating women in Western countries consume alcohol while breastfeeding. Alcohol intake inhibits the milk ejection reflex, causing a temporary decrease in milk yield. The alcohol concentrations in breast milk closely resemble those in maternal blood. The amount of alcohol presented to nursing infants through breast milk is approximately 5–6% of the weight-adjusted maternal dose, and even in a theoretical case of binge drinking, the children would not be subjected to clinically relevant amounts of alcohol. Newborns metabolize alcohol at approximately half the rate of adults. Minute behavioural changes in infants exposed to alcohol-containing milk have been reported, but the literature is contradictory. Any long-term consequences for the children of alcohol-abusing mothers are yet unknown, but occasional drinking while breastfeeding has not been convincingly shown to adversely affect nursing infants. In conclusion, special recommendations aimed at lactating women are not warranted. Instead, lactating women should simply follow standard recommendations on alcohol consumption.

The harmful effects of alcohol during pregnancy are well documented [1] and have led to very restrictive recommendations for pregnant women concerning alcohol intake [2,3]. However, the effects of alcohol during breastfeeding have not been nearly as extensively examined, and the literature on the prevalence of alcohol consumption during breastfeeding is scarce. Previously, it was a common belief that alcohol was beneficial during breastfeeding, and many women were encouraged to drink alcohol while lactating to relax, promote lactation and the milk ejection reflex and to enhance infant sleep [4,5]. This notion has somewhat subsided in recent years in favour of a more cautious approach, but versions of it still surface from time to time, which can cause confusion and concern in new mothers [6].

Current recommendations by regulatory authorities (AUS, US, DK) and the American Academy of Pediatrics seem to be based on a 'better safe than sorry' approach and advise that women abstain completely from alcohol intake until they no longer breastfeed or at least avoid breastfeeding in the hours immediately after alcohol intake [3,7–9]. Various online resources that new mothers may consult similarly advocate abstention or delay before breastfeeding [10,11]. The Motherisk information service at the Hospital of Sick Children in Toronto, Canada, thus – very conservatively – recommends that breastfeeding women delay nursing their children until any ingested alcohol is completely eliminated from the milk or plan ahead by pumping out and storing milk before drinking [10], and a nomogram has been developed in an effort to help the women calculate the length of this delay [12].

The aim of this minireview was to summarize original data on the prevalence of alcohol intake during lactation, the influence of alcohol on breastfeeding, the pharmacokinetics of alcohol in lactating women and nursing infants and the effects of alcohol intake on the nursing infant.

Methods and Results

We searched PubMed from origin to May 2013 for the free-text words 'alcohol' and ('breastfeeding or lactation or human milk'). This resulted in 2090 hits, but after limiting the search to human studies reported in English, 946 remained. Of these, 39 studies were included for this minireview, while two additional references were identified from cross-reference searches. A more specific search strategy, combining the MeSH terms 'breastfeeding', 'lactation' and 'milk, human' with the MeSH term 'ethanol', returned 27, 43 and 55 studies, respectively (using similar restrictions as above), all of which were included in the initial broader search. The included publications are summarized in online table S1.

The literature search and selection of included publications were performed in accordance with PRISMA guidelines [13]. The selection tree is illustrated in fig. 1.

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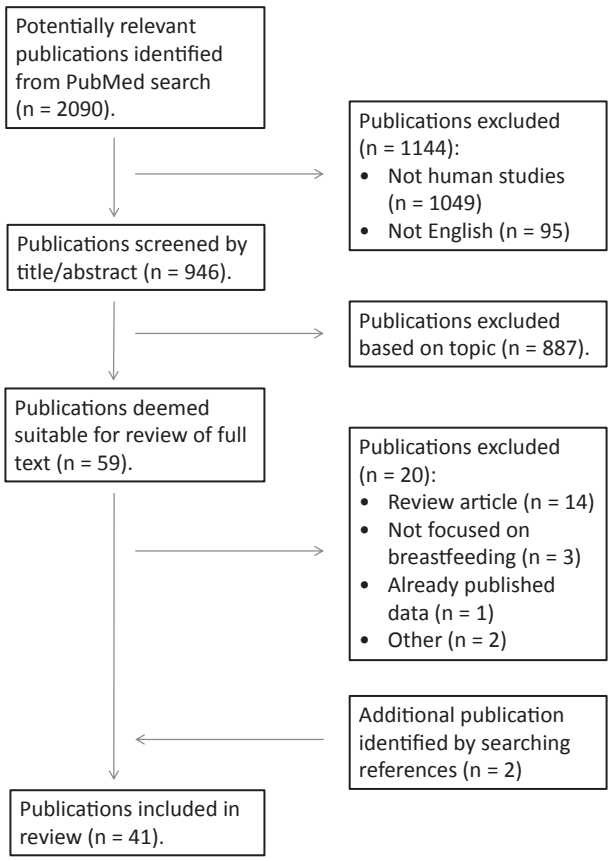

Fig. 1. Flow chart of the selection of publications for inclusion in review.

Prevalence of alcohol intake during breastfeeding.

Eight studies published from 1990 to 2011 have reported prevalences of alcohol intake in lactating women ranging from 36 to 83%, with the highest prevalences seen in the oldest studies, see table 1 [14–21].

Furthermore, in 1981, Davidson *et al.* [22] reported that only 38% of 261 participating women in Canada had received information about alcohol during breastfeeding. Ten percentage had been told to avoid alcohol, 45% that alcohol in moderate amounts was acceptable and 43% that alcohol was beneficial. Most of the women had received this information from healthcare professionals. More than half of the women who had avoided alcohol during pregnancy, consumed alcohol during breastfeeding, and 80% of the women who ingested alcohol during pregnancy, continued to do so while breastfeeding.

In a similar study from 2004, Pepino and Mennella showed that of 167 Argentinian women surveyed, only about one in four had received information from healthcare professionals regarding alcohol intake during lactation. More than 44% reported that they were advised to drink a local alcohol-containing drink, mate, to enhance their lactational performance. The majority had received this advice from family and friends, but 13% had heard it from their physician [23].

Alvik *et al.* [20] showed that in Norway, 51% of the surveyed breastfeeding women ingested alcohol during the first 3 months after delivery, a number that rose to 80% after 3 months. Nearly all of these women reported a weekly intake of <7 standard drinks in the first 3 months, but after 6 months, approximately one in four women still breastfeeding engaged in binge drinking (>5 standard drinks per single occasion). Five percentage of these women had ingested 12 standard drinks on at least one occasion.

Giglia *et al.* [21] reported that in Australia, more than 35% of the breastfeeding women who in the week before the study had ingested alcohol had consumed one or two standard drinks and that over 40% had consumed ≥5 standard drinks. From 1995 to 2001, the percentage of breastfeeding women who had consumed ≥10 standard drinks during the week before the study had increased slightly from 18 to 21%. More than 3% reported a daily alcohol consumption.

Alcohol's effect on breastfeeding.

Breastfeeding is controlled by the two pituitary hormones prolactin and oxytocin [24]. Prolactin stimulates the production of breast milk, and oxytocin causes contraction of the smooth muscle cells surrounding the mammary tissue, thus causing ejection of the milk stored in the breast [24].

Eight studies were identified concerning the effects of alcohol on breastfeeding [25–32]. Contrary to previous beliefs of the beneficial effects of alcohol on breastfeeding, it has been demonstrated that alcohol to some extent inhibits lactation. One study of 22 lactating women, who were asked to express milk on two different days, one of which they had ingested 0.3 g alcohol per kg (corresponding to about 1.8 units of alcohol, assuming a body-weight of 70 kg and an alcohol content of 12 g per unit), showed that the amount of milk expressed was 9.3% lower on average in the first two hours after alcohol consumption [25].

It has also been demonstrated that alcohol dose-dependently inhibits oxytocin and thereby the milk ejection reflex, which could probably explain this reduction in milk yield. However, the inhibitory effect of alcohol on oxytocin is subject to a sizeable interindividual variation [26,27]. Several studies have examined the inhibitory effects of alcohol on oxytocin levels. One such study found a 78% decrease in AUC for oxytocin after breast stimulation in women who had ingested 0.4 g alcohol per kg (or about 2.3 units of alcohol) and a corresponding increase in latency time to milk ejection. The milk yield was also reduced, and the prolactin levels were increased in the hours immediately after alcohol consumption (AUC for prolactin increased by 336 ± 222%) [28]. Another study from Taiwan showed a 52% increase in latency time in women who ingested an alcohol-containing soup as part of a cultural ritual [29].

A more elaborate study of the pharmacokinetics of prolactin in relation to alcohol intake found that the basal prolactin levels were higher after alcohol intake than otherwise and that the effect of breast stimulation on prolactin levels were significantly altered by alcohol intake. If breast stimulation occurred

Table 1.
Prevalence of alcohol intake during breastfeeding (*numbers from 1995 and 2001, respectively).

Authors	Country	Publication year	Methods	No. of women surveyed	Prevalence of alcohol intake during breastfeeding (%)
Matheson *et al.* [14]	Norway	1990	Questionnaire	885	83
Little *et al.* [15]	USA	1990	Interview	220	66
Alvik *et al.* [20]	Norway	2006	Questionnaire	1303	79.9
Parackal *et al.* [16]	New Zealand	2007	Questionnaire	79	66
Breslow *et al.* [17]	USA	2007	Questionnaire	772	35.9
Giglia & Binns [18]	Australia	2007	Interview	287	46.7
Giglia & Binns [21]	Australia	2008	Interview	1461/1248*	42.5/47.8
Maloney *et al.* [19]	Australia	2011	Questionnaire and interview	807	43

during the time span where the alcohol concentration of the blood was increasing, breast stimulation caused significantly higher prolactin levels than if no alcohol had been consumed. If, however, breast stimulation occurred while the alcohol concentration was decreasing, the prolactin levels were statistically significantly lower [30]. The clinical significance of these findings is not yet understood.

Finally, it has been demonstrated that alcohol consumption affects the duration of lactation. Giglia *et al.* [31] showed that women who self-reported a daily alcohol intake of >2 standard drinks were almost twice as likely to discontinue breastfeeding after 6 months than women who reported smaller consumptions. Similar findings were reported by Chaves *et al.* [32].

Pharmacokinetics of alcohol during lactation.

Twelve publications concerning the pharmacokinetics of alcohol during lactation were identified [5,33–43]. Alcohol passes freely into breast milk in approximately the same concentrations as in maternal blood; one study has shown marginally higher concentrations in blood [33], another in milk [34]. The highest concentration is seen after 30–60 min, and the concentration declines linearly at the same rate as in maternal blood (i.e. approximately 15–20 mg/dL/h [1]) due to dynamic equilibrium between plasma and breast milk [33–35]. The toxic metabolite of alcohol and acetaldehyde is apparently not excreted into milk, even at high concentrations in maternal blood [33].

Two studies have examined the pharmacokinetic profile of alcohol in lactating women [36,37]. Pepino *et al.* [36] compared 20 lactating women to nine formula-feeding and 15 nulliparous women of similar age, weight, height and drinking habits. The study showed that the lactating women had statistically significantly lower maximum levels (C_{max}) and systemic availability (area under the curve, AUC) of alcohol in blood than the other two groups and that the time to maximum alcohol concentration (t_{max}) was the same for all groups. Da-Silva *et al.* [37] found similar results in a small study of five lactating women and five age- and BMI-matched controls who ingested 0.4 g alcohol per kg (or about 2.3 units). The lactating women had statistically significantly slower alcohol absorption (t_{max} 48 *versus* 31 min.), lower AUC and lower alcohol levels in blood after 150 min. than the non-lactating women.

There are conflicting reports on the effect of lactation on the rate of elimination of alcohol. Some studies have not shown any effect [34,37], whereas others have demonstrated a difference depending on the timing of nursing [38,39]. One of the latter studies examined the effects of breast stimulation with a breast pump in relation to alcohol intake and found a lower AUC and maximum blood alcohol concentration if breast stimulation was performed one hour prior to alcohol intake in contrast to 0.6 hr after. The rate of elimination was higher when breast stimulation was performed after alcohol intake. There was, however, no comparison group of non-lactating women in this study [38]. A subsequent study from the same authors found that breast stimulation affects the pharmacokinetics of alcohol even after cessation of lactation. Use of a breast pump 0.6 hr after alcohol consumption resulted in a longer t_{max} and higher AUC after cessation of breastfeeding. In contrast, no such difference was found when the women had ingested alcohol one hour prior to breast stimulation [39].

Studies have shown that a maternal alcohol intake of 0.3–0.6 g/kg (about 1.8–3.6 units) leads to a milk concentration of alcohol that would expose the nursing child to 0.0016–0.036 g/kg (i.e. approximately 5–6% of the weight-adjusted maternal dose), if the child is breastfed at the time of maximum alcohol concentration in the milk [5,33,40]. Theoretically, if a mother of 70 kg were to drink four standard drinks (of 12 g pure alcohol) at one occasion and then breastfeed her child at the time of the highest maternal alcohol concentration in blood (assuming complete absorption, a volume of distribution of 35 L and no metabolism of alcohol), the child would be exposed to 1.37 g/L in the breast milk. If the child then were to drink 150 mL milk (assuming a weight of 6 kg, a daily intake of 150 mL/kg over six feedings, and a total body water composition of 70% [41]), the blood alcohol level of the child would be $(0.15\ \text{L} \times 1.37\ \text{g/L})/(0.7\ \text{L/kg} \times 6\ \text{kg}) = 0.049\ \text{g/L}$, or 0.005% (about 1/10 the limit for driving legally in most European countries). The child is consequently exposed to only a fraction of the amount of alcohol ingested by the mother.

Pikkarainen *et al.* [42] reported that the activity of alcohol dehydrogenase in newborns (up to 2 months of age) was approximately one-fourth of the activity seen in adults. The clinical consequences of this difference were somewhat elucidated by Idänpään-Heikkilä *et al.* who examined the rate of elimination of alcohol in mothers and infants. Six women in labour were given an alcohol infusion (8%, 6 mL/min.) until delivery (1.5–3.5 hr), at which point the alcohol levels in the umbilical cord blood were similar to those in maternal blood. During the first 4 hr, the elimination rate of alcohol in the newborns was 7.7 mg per 100 mL blood and 14.0 mg per 100 mL blood in the mothers. After 8 hr, the infants had almost twice as high alcohol blood levels as the mothers (11 ± 3 per 100 mL and 6 ± 2 per 100 mL, respectively) [43]. Given that a nursing infant ingests such a small fraction of the maternal dose of alcohol, the approximately 50% lower rate of elimination in the child should have no clinical significance.

Alcohol's effect on the nursing infant.

Eleven studies on the effects of alcohol on the nursing infant were identified [5,40,44–52]. Of these, three studies of a total of 36 participants have shown that children breastfed by women who had consumed alcohol prior to feeding ingested approximately 20% less milk in the first 4 hr after maternal alcohol consumption than otherwise [5,40,44]. However, the children were breastfed more frequently and thus ingested larger amounts of milk 8–12 hr after maternal alcohol consumption, if the women did not consume any more alcohol [44].

This reduction in the children's milk consumption is not caused by a dislike for the taste of the milk, but should probably be attributed to the reduced milk yield after alcohol intake. Mennella demonstrated that children ingest larger amounts of alcohol-enriched milk than plain milk, when offered to them in a bottle [45].

Small changes in the children's sleep patterns have been reported [5,46,47]. Two studies have shown that the total amount of sleep was unchanged after intake of alcohol-containing milk [5,47], but that the sleep was divided into more, but shorter, intervals [5]. The amount of active (REM) sleep was reduced for the first 3.5 hr in one study and then increased for the next 20.5 hr [47]. In contrast to this, another study from the same group showed that the children's sleep on average was 25% shorter after ingesting alcohol-containing milk and that the number of times the children slept was unchanged [46].

The possible long-term effects of alcohol in mother's milk are unknown. A single, frequently cited case from 1978 of an infant adversely affected by alcohol in the breast milk has been reported. The child was diagnosed with pseudo-Cushing syndrome at 4 months of age, and upon examination, the mother reported a weekly intake of more than 17 L of beer in addition to other alcoholic beverages. The mother was encouraged to discontinue her alcohol intake, and afterwards, the child gradually reverted to a normal development [48].

Little *et al.* [49] found an association between alcohol consumption during lactation and decreased psychomotor development. A total of 400 women, of which 153 reported a daily alcohol intake of two or more standard drinks and 243 reported less, were followed from before delivery until the children were 1 year old. The children of the women with the highest alcohol intake had statistically significantly lower scores on a scale of psychomotor development than the other children. Some of this differences could, however, be attributed to the fact that the mothers in this group were older or potentially other confounders. There was no difference between the children with regard to mental development, and the authors concluded that because any psychomotor development scale at 1 year is but a crude measure, the clinical importance of these findings was unclear. A later register-based study from the same principal author could not reproduce the findings. The authors had information about maternal alcohol intake during lactation and subsequent motor evaluations of 915 children at 18 months of age and were unable to demonstrate any effects of alcohol consumption. However, there were more women who smoked, had a high alcohol intake or used marijuana in the original study [50].

A Mexican study found no difference in rate of growth in children at 6 months of age when comparing the children of 32 women with a daily intake during pregnancy and lactation of 1–2 L of pulque (a fermented drink with 3% alcohol) with the children of 62 women without a daily alcohol intake [51]. A later study, also from Mexico, of 58 mothers and children showed that the children of the women with the highest daily pulque intake during lactation had a statistically significantly poorer growth at 5 years of age, regardless of maternal pulque intake during pregnancy. The mothers in this group were, however, older than the 67 mothers in the control group who did not have a daily alcohol intake [52]. The clinical interpretations of both of these studies are severely compromised by poor confounder control.

Comment.

The issue of alcohol and breastfeeding is subject to significant interest from various healthcare organizations and healthcare authorities that usually discourage even minimal consumption during lactation [3,7,10]. The amount of original research data published on this subject is scarce, and for obvious reasons, it is not possible to conduct well-designed studies examining the effects of alcohol on infants. Consequently, a few – largely unsubstantiated – reports of harmful effects on the children have gained much attention. Most of the published clinical studies are hampered by sample-size issues and lack of sufficient confounder control. A disproportionate amount of the clinical studies are published by the same research group, which could possibly lead to recruitment bias and compromise the generalizability of these data [5,23,25,28,30,36,39,40,44–47].

There are two principally different situations of interest when considering the effects of alcohol intake during lactation: chronic abuse and occasional use. The potential effects on children nursed by women with a chronic alcohol abuse are yet unknown, and the studies attempting to elucidate this point so far have been unable to distinguish between the effects of alcohol *per se* and

the secondary effects caused by maternal neglect and other important sociodemographic confounders related to abuse.

Alcohol is excreted into breast milk in concentrations similar to those in maternal blood, which means that the amount of alcohol ingested by the children through breast milk is a fraction of the amount ingested by the mothers. Assuming the worst possible scenario where a mother engages in binge drinking and ingests four drinks of 12 g pure alcohol and then breastfeeds her child at the time of the maximum blood alcohol concentration, the child would still not have a blood alcohol level of more than 0.005%. It appears biologically implausible that occasional exposure to such amounts should be related to clinically meaningful effects to the nursing children. The effect of occasional alcohol consumption on milk production is small, temporary and unlikely to be of clinical relevance. Generally, there is little clinical evidence to suggest that breastfed children are adversely affected in spite of the fact that almost half of all lactating women in Western countries ingest alcohol occasionally.

If a mother wants to be completely certain that she does not expose her child to alcohol, the Motherisk nomogram may be used. This nomogram shows the time of elimination for a given amount of alcohol, depending on the body-weight of the mother. Assuming an average maximum rate of alcohol elimination of 15 mg/dL/h and an alcohol content of approximately 17 g per standard drink, it is expected that the alcohol will be completely eliminated from the milk after 110–170 min per standard drink, after which point, the authors consider it safe to resume breastfeeding [12]. The underlying assumptions for these estimations are very conservative in terms of alcohol content per drink [3,7]. This recommendation appears to represent an overly cautious approach that is not supported by factual evidence, and such a nomogram is not easily accessible to the average consumer of alcohol.

The present recommendations for adult women not currently pregnant or breastfeeding are to drink no more than 20 g pure alcohol (two AUS standard drinks) on any day [3] or 14 g pure alcohol (one US standard drink) daily and no more than four drinks at any one time [7]. Such amounts of alcohol do not expose the nursing infant to clinically relevant amounts of alcohol, as demonstrated above.

Conclusion

While the effect from long-term exposure to alcohol during lactation remains unknown, complying to standard recommendations from healthcare authorities on alcohol intake for women does not result in nursing children being exposed to clinically relevant amounts of alcohol, and special precautions for lactating women are not necessary.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Publications included in review.