Published in final edited form as:

Arch Womens Ment Health. 2015 December ; 18(6): 773–781. doi:10.1007/s00737-015-0568-2.

The relationship between alcohol consumption and menstrual cycle: a review of the literature

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Abstract

Alcohol use affects men and women differently, with women being more affected by the health effects of alcohol use (NIAAA, 2011). Yet, a dearth of information investigating the alcohol use in women exists (SAMSHA, 2011). In particular, one dispositional factor hypothesized to contribute to alcohol consumption in women is the menstrual cycle. However, only 13 empirical papers have considered the menstrual cycle as related to alcohol consumption in women. These studies fall out with somewhat mixed findings suggesting that the premenstrual week is associated with increased, decreased, or no change in alcohol consumption, likely due to methodological differences in menstrual cycle determination and measures of alcohol consumption. These methodological differences and possible other contributing factors are discussed here with recommendations for future research in this area. Understanding the contribution of the menstrual cycle to alcohol consumption is one step in addressing an important women's health concern.

Keywords

Alcohol consumption; Menstrual cycle; Women; Women's health

Women and alcohol

Alcohol use disorders place a high burden upon society, with estimations of annual public health costs exceeding \$223 billion (Bouchery et al. 2011). Although alcohol use disorders have historically been higher in men, recent epidemiological evidence suggests the gap in prevalence of alcohol use and dependence between women and men is decreasing (e.g., Grant et al. 2008). Moreover, men and women face different health risks. For example, women are at greater risk for alcohol-related health problems such as liver or heart disease as compared to men (National Institute on Alcohol Abuse and Alcoholism, NIAAA 2011). As such, understanding the underpinnings of alcohol use has become an important women's health issue.

Research has shown that women and men also respond differently to alcohol, specifically, women become intoxicated with lower quantities of alcohol (e.g., Mumenthaler et al. 2001; Frezza et al. 1990). Among individuals who eventually develop alcohol use disorders,

women progress more quickly from initial use to abuse than men, a phenomenon called “telescoping.” Yet, there has been an overall dearth of research investigating alcohol use in women (Substance Abuse and Mental Health Services Administration, SAMHSA 2011). A recent Institute of Medicine (2010) report indicated existing studies either neglect to include women or fail to account for gender differences. Especially given the occurrence of telescoping, elucidating the etiological factors that uniquely contribute to drinking in women is an important women’s health priority in order to effectively inform prevention and treatment programs for women. One such etiological factor hypothesized to contribute to average differential patterns of drinking in women is the menstrual cycle and yet little current and cutting edge research exists. Thus, our goal is to summarize the state of the science in this area and to offer suggestions for much needed research.

Menstrual cycle

Endocrine overview

Myriad reports summarize the endocrinology of the cycle from the classic review by Franz (1988) to more recent detailed analyses (Jabbour et al. 2006). Menstrual endocrinology may be considered a well-understood part of the scientific canon, and as such, we offer a brief and relevant overview here (for more information, see Lustyk et al. (2014)).

Briefly, the menstrual cycle has a frequency of about 21–35 days in reproductively fit women. Broadly defined, it has two phases: follicular and luteal (see Fig. 1). The follicular phase begins with the first day of menstrual bleeding (day 1 of the cycle) and ends with ovulation. The follicular phase is characterized by relatively steady levels of ovarian estrogen and progesterone, with an increase in estrogen just before ovulation. Conversely, the luteal phase follows ovulation and is characterized by rising progesterone and estrogen levels and is the only time during the cycle in which progesterone is unopposed by estrogen. Given the lifespan of the corpus luteum, the luteal phase has a duration of 14 ± 2 days.

Implications for research protocols

To assess women during different cycle phases, researchers apply the above frequency rules. For example, the menstrual period can be easily captured by counting forward from day 1 of bleeding (e.g., Epstein et al. 2006), while assessment during a time of relatively steady hormone output can be performed during the mid-follicular phase (i.e., about days 5–7, e.g., Charette et al. 1991). Given that a surge in estrogen and gonadotropic hormones precedes ovulation, researchers wishing to capture this time period may employ a pre- or peri-ovulatory window, which can easily be tracked with multitude non-invasive ovulation detection methods allowing for assessments at ovulation (e.g., Griffin et al. 1987). Once ovulation has been detected, researchers may perform assessments throughout the luteal phase to study the influence of unopposed progesterone mid-luteal (e.g., Tate and Charette 1990) and/or the withdrawal of hormones which occurs during the late luteal phase (i.e., the premenstrual week or 8–12 days after ovulation (e.g., Pomerleau et al. 1994)).

Only recently have researchers begun to study the effects of cycle phase on substance use and abuse as well as treatment acceptance and efficacy (for overview, see Douglas et al.

2013). As a burgeoning area of research, few studies have investigated the variables known to affect alcohol use in women including the menstrual cycle, which may contribute to behavioral changes in alcohol use. One area of focus is negative affect. For example, Lustyk et al. (2010) have shown that the luteal phase is a time of heightened stress reactivity. Given the intricate relationship between stress and alcohol use (Sinha 2008), it may be that increased stress vulnerability as in the luteal phase may elicit drinking to cope in women. However, research regarding alcohol consumption and menstrual cycle has been mixed, and the remainder of this review will summarize the research to date, paying particular attention to the cycle phase measurement methods employed, and provide a summary of how the data presented may help us understand the underpinnings of menstrual cycle effects on alcohol use.

Early research on menstruation and alcohol use

Before the mandate to include women in research was made in the 1990s, many researchers were excluding women because of the “unstability” of the menstrual cycle phase (Lammers et al. 1995). Belfer et al. (1971) published an early investigation on the association between menstrual cycle and alcohol use. At that time, virtually no empirical research existed on the topic, and deductions of a connection between alcohol and menstrual cycle phase posited that the menstrual cycle is disruptive, and disruption leads to drinking.

Since then only a few reviews (Turner and de Wit 2006; Lammers et al. 1995; Blume 1986) have outlined research on alcohol use in women by menstrual cycle. Blume (1986) provided an early review of alcohol use in women that devoted one paragraph outlining the postulated association of alcohol use and menstrual cycle. More recently, reviews by Lammers et al. (1995), and Turner and de Wit (2006) focus more specifically on the responses to alcohol across the menstrual cycle.

Lammers et al. (1995) focus on the pharmacokinetics of alcohol use (or the physiological response to alcohol) in women by cycle phase. They conducted a literature search of articles that (1) utilized within subjects design and included freely cycling women; (2) included appropriate time points of the menstrual cycle to capture significant variations in hormones. In particular, the studies had to compare at least a time when there would be high progesterone and estrogen in the late luteal phase (days 19–25), when there was low progesterone and estrogen in the premenstrual and early follicular phase (days 28–7), and when estrogen was high around the late follicular phase before ovulation (days 9–15); and (3) confirmed the occurrence of ovulation by measuring hormones. Only two studies met their criteria. One was a dissertation conducted by King (1984) and the second a study by Sutker and colleagues that resulted in two papers (Sutker et al. 1987a, b). These studies found that elimination times (i.e., time in minutes for alcohol levels to reduce from peak blood alcohol content to essentially zero) are higher in the early follicular phase than in the late luteal phase, and disappearance rates (i.e., rate of change per hour in the slope in the descending limb of the blood alcohol content curve) are higher in the late luteal phase than early follicular phase. In essence, the mid-luteal phase was found to be associated with slightly quicker elimination of alcohol. Given that these studies originate from the same lab and had not been independently replicated, Lammers et al. (1995) concluded there was no

significant evidence to suggest that alcohol pharmacokinetics are altered by cycle phase. Thus, Lammers and colleagues deduced women should not be excluded from pharmacokinetic research on alcohol use. The review by Lammers et al. (1995) selected studies based on ideal guidelines for methodologically rigorous menstrual cycle research, yet the literature review was overly restricted and excluded many relevant studies.

An additional review by Turner and de Wit (2006) outlined the effects of a variety of drugs, including alcohol, across the menstrual cycle and found similar results to the Lammers review. In contrast to the strict criteria of Lammers et al. (1995), Turner and de Wit indicated no criteria for inclusion in their review, but included 13 studies investigating the behavioral and physiological effects of alcohol by menstrual cycle. Of these 13 studies, 8 identified no cycle phase effects on alcohol including studies the pharmacokinetics of alcohol by cycle (e.g., Freitag and Adesso 1993) and the quantity of alcohol consumed by cycle (e.g., Pomerleau et al. 1994). Turner and de Wit (2006) also delineate early studies that identify cycle phase differences, such as the study conducted by Sutker et al. (1987a, b) already reviewed by Lammer and colleagues. Additionally, three other studies reviewed find menstrual cycle phase differences in relation to alcohol in pharmacokinetics and alcohol consumption. Regarding pharmacokinetics, Turner and de Witt delineate findings that alcohol pharmacokinetics affect women more in the luteal phase. Specifically, plasma levels of ethanol are correlated with anxiety scores in the luteal phase, but not the follicular phase (Logue et al. 1981), and alcohol elimination times are lower mid-luteally and alcohol disappearance rates are higher mid-luteally (Sutker et al. 1987a, b). Regarding alcohol consumption, Harvey and Beckman (1985) found self-reported alcohol intake is highest in the luteal phase. Given the preponderance of null results, Turner and de Wit (2006) concluded there is no consistent evidence of differential pharmacokinetic or behavioral patterns of alcohol use in humans by menstrual cycle phase.

Although both Lammers et al. (1995) and Turner and De Wit (2006) reached similar conclusions, both reviews exclude a great number of studies investigating alcohol use and the menstrual cycle. A more rigorous review, with appropriate scope, is required to outline current findings on alcohol use by menstrual cycle phase. Given the women's health significance of alcohol use in women, it is of interest to identify alcohol consumption in women as related to menstrual cycle. However, no review to date has systematically identified the effects of menstrual cycle phase on alcohol consumption.

Literature review

We searched all current academic articles conducted in human females on “menstrua*” and “alcohol” in PsychInfo and PubMed and found 44 relevant empirical articles on alcohol and menstrual cycle phase. However, we excluded articles that did not look specifically at alcohol consumption by cycle phase, which left only 13 studies that investigate the relationship between alcohol consumption measured by quantity and/ or frequency and menstrual cycle phase (see Table 1).

Menstruation and alcohol consumption

A review of the 13 studies that investigate alcohol consumption by menstrual cycle phase lends three main findings: alcohol consumption increases premenstrually/menstrually; alcohol consumption decreases premenstrually; or there is no change in alcohol consumption by cycle phase. The sample characteristics, methodology around menstrual cycle phase and alcohol use, and the main findings of these studies can be found in Table 1.

Alcohol consumption increases premenstrually/menstrually

Seven of the 13 studies investigating alcohol consumption by cycle phase find increased premenstrual/menstrual alcohol consumption (Allen 1996; Belfer et al. 1971; Marks et al. 1994; Mello et al. 1990; McLeod et al. 1994; Svikis et al. 2006; Epstein et al. 2006).

Of these studies, two used open-ended self-reported occurrence of drinking during the menstrual cycle to measure alcohol consumption (Belfer et al. 1971; Allen 1996). Belfer et al. (1971) assessed alcohol consumption in 34 women with alcoholism and 10 women who had come to the alcohol clinic with their husbands with alcohol use disorders (97 % White). No structure is given for the assessment of alcohol use, but Belfer and colleagues reported that 67 % of menstruating women and 48 % of non-menstruating (retrospective recall) women reported drinking more premenstrually and during the menstrual phase. In a more recent investigation, Allen (1996) asked 48 freely cycling women (race/ethnicity not reported) what “time of month you drink more” and found that 33 % of women reported more alcohol use premenstrually. In combination, these studies provide a broad range for the percentage of women who reported increases in alcohol use related to the premenstrual period (33–67 %). Additionally, little rigor surrounds the questions posed to women on alcohol consumption or what defines the “premenstrual” period. Thus, these response patterns of women identifying the pre-menstrual period as more problematic for drinking may be driven by the ethos of social ideas about women and drinking.

Five additional studies found increases in alcohol consumption premenstrually (Epstein et al. 2006; Svikis et al. 2006; Mello et al. 1990; McLeod et al. 1994) or menstrually (Marks et al. 1994). First, Marks et al. (1994) investigated alcohol consumption by cycle phase in nine nicotine smokers (100 % White) with Late Luteal Phase Dysphoric Disorder (LLPDD, now known as Premenstrual Dysphoric Disorder). Alcohol use was measured across two menstrual cycle phases using a single self-reported rating of alcohol and other drug use ranging from “not at all to extreme” alcohol or other drug use. In the nicotine smokers with LLPDD, alcohol consumption peaked during the menstrual phase (all bleeding days) as compared to the other menstrual cycle phases (see Table 1).

Two studies looked at family history of alcohol use as a moderator of increased alcohol consumption (McLeod et al. 1994; Svikis et al. 2006). McLeod et al. (1994) investigated alcohol consumption by cycle phase in 54 women with Generalized Anxiety Disorder, 41 of whom had a positive family history of alcohol use disorders and 13 of whom had no family history of alcohol use disorders (81 % White). Self-reported increase in alcohol consumption was assessed in the follicular (undefined) and premenstrual (undefined) periods of a single

menstrual cycle. Results suggested alcohol consumption increased premenstrually for those with a family history of alcohol use only.

Similarly, Svikis et al. (2006) investigated alcohol consumption by cycle phase in 46 women with Premenstrual Syndrome, 17 with a positive family history of alcohol use disorders and 29 with no family history of alcohol use disorders (73 % White). Daily diary of alcohol consumption, quantified as drinks per week, was kept for between two and three menstrual cycles to compare the follicular (the 7 days mid-cycle before ovulation) and the premenstrual period (–7 days to menstruation) alcohol use. Results suggested that alcohol consumption increased premenstrually, again for those with a family history of alcohol use only.

One study conducted by Epstein et al. (2006) compared alcohol consumption across menstrual cycle phases in women receiving treatment for alcohol use. The 12 women (100 % White) analyzed in this study came from a larger clinical trial. Alcohol consumption was measured with daily diary entries that yielded percentage drinking days and mean drinks consumed per day. Results revealed that the premenstrual period (–7 days to menstruation) was associated with more alcohol consumption than the menstrual (bleeding days) or other cycle phases (all other days).

Mello et al. (1990) methodology differed from the previously reported studies in that they did not use self-reported alcohol use, but in vivo operant alcohol procedures to measure alcohol consumption. In this study, 14 female participants who reported regularly using alcohol (race/ethnicity not reported) lived in an experimental laboratory for a month where they could earn alcohol by engaging in operant response tasks (approximately 30 min of work per drink). Women completed daily diaries of premenstrual symptoms. Alcohol consumption was compared across the menstrual (days 1–3), late luteal (or as they called it pre-premenstrual period –5 days leading up to the premenstrual period), and premenstrual periods (–3 days to menstruation). Results suggest that alcohol use premenstrually was related to the premenstrual symptom profiles. Women with no changes in alcohol use across cycles had no premenstrual symptoms, whereas women whose alcohol use increased premenstrually had the highest premenstrual symptoms in areas of emotional well-being, and women whose alcohol use decreased premenstrually were highest in symptoms of physical discomfort. Thus, results suggest that alcohol consumption may increase premenstrually in order to cope with negative emotionality during the premenstrual period.

Alcohol consumption decreases premenstrually

In direct contrast to the findings that alcohol consumption increases premenstrually, a commonly cited study by Harvey and Beckman (1985) found decreased alcohol consumption in the premenstrual phase. This study was conducted with exceptional rigor, yet no replication, to date, has supported these findings. Participants in this sample were 69 healthy students and staff at UCLA (81 % White), who kept daily diaries for two to three menstrual cycles of their alcohol consumption, defined as both number of days that alcohol was consumed and an average alcohol consumption by day by dividing the absolute alcohol by the number of drinking days in each cycle phase. A drop in basal body temperature

confirmed ovulation. Alcohol use, defined by number of days of drinking, and absolute alcohol/drinking days in the cycle phase in question (variables used to calculate not reported) were found to be lowest in the pre-menstrual period (–3 days leading up to menstruation) as compared to other cycle phases (see Table 1).

No change in alcohol consumption by cycle phase

An additional five studies found no change in alcohol consumption by cycle phase (Charette et al. 1991; Christensen et al. 1989; Griffin et al. 1987; Pomerleau et al. 1994; Tate and Charette 1990). However, the studies by Charette et al. (1991); Tate and Charette (1990) were conducted on the same sample, so they are discussed in conjunction.

In line with the studies by Belfer et al. (1971) and Allen (1996) which assessed self-reported alcohol use, Christensen et al. (1989) investigated self-reported alcohol consumption across the menstrual cycle phase in 43 women: 13 of whom had severe premenstrual syndrome symptomatology, 17 of whom had mild premenstrual symptomatology, and 13 of whom had no premenstrual symptomatology (race/ethnicity not reported). Daily diary of alcohol use, assessed via a rating of if the participant “drank more alcohol,” was kept for a complete menstrual cycle. They compared premenstrual (undefined) and postmenstrual (undefined) ratings of alcohol consumption and results revealed no change in alcohol consumption across menstrual cycle phases.

In line with the studies of family history of alcohol use by McLeod et al. (1994), Svikis et al. (2006), and Charette et al. (1991) investigated alcohol consumption in 82 healthy women (race/ethnicity not reported), of whom 52 had a positive family history of alcohol use disorders and 30 had no family history of alcohol use disorders, over two menstrual cycles. In an extension of the Charette et al. (1991) study, Tate and Charette (1990) analyzed “the same subjects reported on by Charette et al. (1991),” utilizing 81 of the 82 participants reported on in the first paper. Alcohol was assessed by daily diaries of the number of drinks, alcohol type, and setting where alcohol was consumed. They compared menstrual (days 1–3), follicular (3 days in between menses and ovulation), ovulation (–14±1 day to menses), luteal (3 days in between ovulation and menses), and premenstrual (–3 to menses) phases of alcohol use. In sum, Charette et al. (1991) and Tate and Charette (1990) found no change in alcohol consumption by cycle phase.

Two studies assessed alcohol consumption in smokers of marijuana (Griffin et al. 1987) or nicotine (Pomerleau et al. 1994). First, Griffin et al. (1987) investigated alcohol consumption across the menstrual cycle phase in 30 regular alcohol and marijuana users (93 % White). Daily diary of alcohol use, assessed via number of drinks, type of alcohol, and quantity of alcohol use, was assessed over three menstrual cycle phases. They compared menstrual (undefined), follicular (menstrual to ovulation), peri-ovulatory (–14±1 day to menses), luteal (peri-ovulatory to premenstrual), and premenstrual (–3 days to menses) phases of alcohol use and results revealed no change in alcohol consumption across menstrual cycle phases.

Finally, Pomerleau et al. (1994) investigated alcohol consumption across the menstrual cycle phases in 22 regular nicotine smokers (race/ethnicity not reported). Daily dairy of alcohol

consumption as measured via standard drinks consumed each day was kept for one menstrual cycle. They compared menstrual (all bleeding days), follicular (menstrual to ovulation), ovulatory (–16 to –12 day to menses), luteal (–11 to –8 to menses), and premenstrual (–7 to –1 days to menses) phases of alcohol use and results revealed no change in alcohol consumption across menstrual cycle phases.

Discussion

A review of the literature on the effects of menstrual cycle phase leaves mixed findings. While somewhat inconclusive, there may be justification for the mixed findings including methodological issues. First, there are few studies to draw on for this topic, and it is important to note that several of the studies were conducted out of the same lab and support similar findings. While this does not negate the findings of the studies, this observation points out overlap in studies conducted within the same lab in theory, methods, and measures that may influence likelihood of obtaining similar results within labs and disparate results across labs.

Next, some of these discrepancies can be attributed to methodological differences in measuring cycle phase. The studies conducted by Allen (1996) and Belfer et al. (1971) made no effort to control for or address the definition of cycle phase, so their results could be highly biased by what lay people consider “premenstrual.” Three of the remaining five studies that found an increased amount of alcohol use in the premenstrual/menstrual phase (Marks et al. 1994; Svikis et al. 2006; Epstein et al. 2006) and only one of the studies that found no change in alcohol consumption (Pomerleau et al. 1994) used the same 7-day window leading up to menstruation to define the premenstrual period. In contrast, the study that found decreased alcohol consumption premenstrually (Harvey and Beckman 1985), 3 of the 5 studies that found no change in alcohol consumption by cycle (Charette et al. 1991; Griffin et al. 1987; Tate and Charette 1990), and one of the studies that found increased alcohol consumption premenstrually (Mello et al. 1990) used a 3 day window leading up to menstruation. The remaining several studies did not define what they meant by “premenstrual” and found both increased (McLeod et al. 1994) and decreased (Christensen et al. 1989) alcohol consumption in the premenstrual phase. Thus, a general trend of a more inclusive window (7 days) being associated with findings of increased alcohol consumption and a shorter window (3 days) being associated with no change, or a reduction, in alcohol consumption emerges. However, there are other methodological variations in these studies, so there may be other contributing factors than menstrual cycle window. While the premenstrual period emerges as the phase of most interest in this literature, the methodology to assess the other cycle phases is important because the other cycle phases are often used as comparisons to the premenstrual period or even as periods of hormonal stability. Thus, different ideas of what constitutes each cycle phase may capture different hormonal events and contribute to mixed findings.

Moreover, methodological problems in confirming ovulation exist in most of these studies. With one exception (Harvey and Beckman 1985), no studies made any effort to confirm ovulation. Harvey and Beckman (1985) used a drop in basal body temperature to confirm ovulation. Future studies could test for luteinizing hormone, which stimulates ovulation (T.

E. R. H. L. S. Group 1998). It is important to verify ovulation in conducting research relating physical, behavioral, or emotional factors to menstrual cycle phase because the hormonal profile of anovulatory cycles is markedly different than cycles with ovulation. With an approximate 10 % of cycles being anovulatory among free-cycling women, a high number of participants in these studies may have anovulatory cycles that contribute to a different hormonal profile.

Another contributor to changes in progesterone premenstrually is hormonal birth control. In the current review, two studies did not exclude for oral contraceptive use (Belfer et al. 1971; Svikis et al. 2006). Both studies that did not control for oral contraceptives found increases in alcohol consumption premenstrually. However, because the premenstrual hormone levels are possibly altered in these samples, changes in alcohol consumption may not be related to the premenstrual hormonal profile.

In addition to methodological variation in defining cycle phase, the studies reviewed here vary greatly in what is used to define alcohol consumption. Many validated measures of standard ethanol content consumption exist, such as the Time-line Follow Back (Sobell et al. 1996). However, several studies here used unstandardized open-ended questions about alcohol consumption (Allen 1996; Belfer et al. 1971; McLeod et al. 1994), single items on measures of alcohol use (Christensen et al. 1989; Marks et al. 1994), or did not specify the constraints around what defined a “drink” (Charette et al. 1991; Tate and Charette 1990; Svikis et al. 2006; Harvey and Beckman 1985). Only Pomerleau et al. (1994) indicated using standard drinks for calculating alcohol consumption, and they found no change in alcohol consumption by cycle. Mello et al. (1990) used particularly unique methods by requiring their participants to live in a laboratory setting where they could earn a “drink” (undefined) by completing 30 min of operant work. Their results were somewhat inconclusive, with different premenstrual syndrome symptom profiles predicting differential alcohol consumption by cycle phase (Mello et al. 1990).

Additionally, many of the participant pools used in the reviewed studies contained few participants (e.g., Marks et al. 1994), used convenience samples of college students (e.g., Harvey and Beckman 1985), and did not report race or included entirely white samples (e.g., Tate and Charette 1990; Epstein et al. 2006). The study with the highest number of participants was conducted by Charette et al. (1990) with 82 participants who at least 81 of whom were Caucasian (race not reported in Tate and Charette, 1990, but 100 % of the 81 participants in Charette et al. (1990) were Caucasian). One study by Marks et al. (1994) had only nine participants, who were also all Caucasian. While Harvey and Beckman (1985) used fairly stringent methodology, their sample was entirely comprised of 69 UCLA-affiliated students and staff. Many studies did not report race (Allen 1996; Charette et al. 1991; Christensen et al. 1989; Mello et al. 1990; Pomerleau et al. 1994), and the most diverse samples contained 73 % Caucasian participants (Svikis et al. 2006). Social constructs of the menstruating woman vary by culture, and diverse samples may help tease out some of the social and hormonal contributors to alcohol use by cycle phase. Thus, future studies should aim to encompass more participants drawing from more diverse populations.

While there are some limitations in the studies reported here, there are many strengths. With such a dearth of information out there on alcohol consumption across the menstrual cycle phases, each of these studies contributes an important piece of information towards a goal of understanding alcohol use in women. Many of these studies are conducted prospectively, use daily diary, and follow women for many cycles (e.g., Charette et al. 1990).

Conclusions

Based on the present review of the existing research on alcohol consumption by menstrual cycle over more than 40 years, the primary conclusion to be drawn may be that the vast majority of this research suffers from significant limitations. The findings are varied, with the majority of studies finding either increased premenstrual alcohol consumption or no change in alcohol consumption by cycle. Methodological rigor in these studies is weak, with methods varying across the 13 studies reviewed here in cycle phase determination and measures of alcohol consumption. Recommendations for future research include more rigorous practices surrounding cycle phase determination and alcohol consumption measures and utilizing diverse samples with sufficient participants for appropriate statistical power.

Research on menstrual cycle can be effectively conducted by following these recommendations. First of all, research should control for hormonal contraceptive use to ensure the hormonal profile is that of freely cycling women. Controlling for hormone use by utilizing freely cycling women as participants increases the likelihood that the hormonal profile follows the expected patterns. Secondly, menstrual cycle determination should use clear and standardized definitions of menstrual cycle phase. At a minimum, researchers should control for cycle phase of test administration and acknowledge the hormonal profile targeted in the menstrual cycle phase. For example, providing a rationale for the window used in assessing the premenstrual week to measure falling progesterone. In a more ideal design, research should utilize repeated measures design to discern within women between the follicular and luteal phases of the cycle. Optimal measurement of the follicular phase and luteal phase would occur during the mid-follicular phase or days 5–9 following the first day of menstrual bleeding when progesterone and estrogen are steady and in the luteal phase in days 8–12 following confirmed ovulation when progesterone and estrogen are dropping. For a more nuanced perspective of cycle phases, the task force on menstrual cycle research delineates cycle phases for research in women (Sommer 1986). Additionally, research should confirm ovulation in women to ensure the latter part of the menstrual cycle has the hormonal profile expected. Ovulation confirmation can be easily obtained with luteinizing hormone pee sticks or more thoroughly with basal body temperature.

Research on alcohol use in women would be much improved by using validated standardized drinking measure (e.g., standard ethanol content) to assess alcohol consumption accurately. For instance, the Timeline Follow Back (Sobell et al. 1996) is a calendar assessment where participants are guided through a calendar period to assess each day for alcohol and other drug use. Alcohol consumption is then calculated based on standard ethanol content of beverages consumed. The Timeline Follow Back has been found to be a reliable measure of alcohol consumption by recall. If these recommendations are addressed, future studies may help address a major women's health and public health

concern by elucidating if menstrual cycle is one part of the determinates of alcohol consumption in young adult women.

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Fig. 1. Menstrual cycle phase and approximate hormonal profile of estrogen and progesterone

Table 1

Literature review of the effect of menstrual cycle on alcohol consumption

Reference	Sample		OC	Cycle phase determination		OV No. cycle	Alcohol use	Results
	N	Characteristics		% W				
Allen 1996	48	Healthy	x		Open-ended "time of month" you drink?		Self-reported increases	33 % report alcohol increase Pre-M
Belfer et al. 1971	44	34=alcoholic; 10=alcoholic husband		97	Self-reported patterns of drinking by cycle phase		Self-reported increases	67 % menstruating, 48 % non-menstruating report alcohol increase Pre-M
Charette et al. 1991	82	52=no FH; 30=FH	x		M, 1 to 3 F, 3 days mid M and OV OV, days 14±1 to M L, 3 days mid OV and M Pre-M, -3 to M	2	DD, #, type, setting	No change in alcohol by cycle
Christensen et al. 1989	43	13=severe PMS, 17=mild PMS, 13=no PMS	x		PostM, undefined Pre-M, undefined	1	DD, daily rating of "more alcohol"	No change in alcohol by cycle
Epstein et al. 2006	12	Women in treatment for alcohol	x	100	M, bleeding Pre-M, -7 to M Other, all other days	1-7	DD, % drink days, mean drinks day	Increased alcohol Pre-M
Griffin et al. 1987	30	Regular alcohol and marijuana users	x	93	M, undefined F, M to OV OV (PeriOV), -14±1 to M L, OV to Pre-M Pre-M, -3 to M	3	DD, #, type, quantity, not indicated as standard	No change in alcohol by cycle
Harvey and Beckman 1985	69	Healthy	x	81	M, bleeding F, M to OV OV, day BBT drop + 3 days L, OV to Pre-M Pre-M, -3 to M	BBT 2-3	DD, # days, absolute alcohol/ drink days in phase	Alcohol quantity lowest Pre-M
Marks, et al. 1994	9	Nicotine smokers with LLPDD	x	100	M, all bleeding days F (PostM), M to OV OV, -16 to -12 to M L (PostOV), -11 to -8 to M Pre-M, -7 to M	2	DD, alcohol or other drug rating not at all to extreme	Alcohol peak during M
McLeod et al. 1994	54	Generalized Anxiety Disorder, 41=FH, 13=no FH	x	81	F, undefined Pre-M, undefined	1	Self-reported increases	FH increased alcohol Pre-M
Mello et al. 1990	14	Regular alcohol users	x		M, 1 to 3 L (Pre-M), -5 to Pre-M Pre-M, -3 to M	1	30 min operant work per drink	Increased alcohol Pre-M
Pomerleau et al. 1994	22	Regular nicotine smokers	x		M, all bleeding days F (PostM), M to OV OV, -16 to -12 to M L (PostOV), -11 to -8 to M Pre-M, -7 to -1 to M	1	DD, drinks per day (standard)	No change in alcohol by cycle

Reference	Sample		OC	Cycle phase determination		OV No. cycle	Alcohol use	Results
	N	Characteristics		% W				
Sviklis et al. 2006	46	PMS, 17=FH, 29=no FH		73	F, 7 days mid-cycle pre OV Pre-M, -7 days M	2-3	DD, drinks per week	FH increased alcohol Pre-M
Tate and Charette 1990	81	Healthy	x	100	M, 1 to 3 F, 3 days mid M and OV OV, days 14±1 to M L, 3 days mid OV and M Pre-M, -3 to M	2	DD, undefined	No change in alcohol by cycle

OC oral contraceptive, indicated if women taking hormonal birth control were excluded, No. cycle number of cycles assessed in study, OVovulation, % Wpercent of sample that was White, FHfamily history of alcohol use, paternal side, PMSPremenstrual Syndrome, LLPDDLate Luteal Phase Dysphoric Disorder, Mmenstrual period, Ffollicular period, L luteal period, Pre-Mpremenstrual period, BBT basal body temperature, DD daily diary