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The Influence of Hormonal Contraception on Mood and Sexual Interest among Adolescents

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Abstract Mood and sexual interest changes are commonly cited reasons for discontinuing hormonal contraceptives. Data, however, are inconsistent and limited to adult users. We examined associations of hormonal contraceptive use with mood and sexual interest among adolescents. We recruited 14–17-year-old women from primary care clinics and followed them longitudinally for up to 41 months. Participants completed face-to-face interviews quarterly and two 12-week periods of daily diary collection per year. On daily diaries, participants recorded positive mood, negative mood, and sexual interest. We classified 12-week diary periods as "stable OCP use," "non-use," "initiated use," "stopped use," and "DMPA use" based on self-report of oral contraceptive pill (OCP) use and depot medroxyprogesterone acetate (DMPA) use from medical charts. Diary periods were the unit of analysis. Participants could contribute more than one diary period. We analyzed data using linear models with a random intercept and slope across weeks in a diary period, an effect for contraceptive group, and an adjustment for age at the start of a diary period. Mean weekly positive mood was higher in diary periods characterized by stable OCP use, compared to other groups. Mean weekly negative mood was lower in diary periods characterized by stable OCP use and higher in periods characterized by DMPA use. Periods characterized by stable OCP use additionally showed less mood variation than other groups. Changes in mood among adolescent hormonal contraceptive users differed from those anticipated for adult users. Attention to adolescent-specific changes in mood and sexual interest may improve contraceptive adherence.

Keywords Adolescent · Oral contraceptives · Sexual interest · Sexual desire · Mood · Daily diaries · Depot medroxyprogesterone acetate

Introduction

Changes in mood and sexual interest are commonly cited reasons for discontinuing hormonal contraceptives (Hatcher et al., 2004; Kay, 1984; Sanders, Graham, Bass, & Bancroft, 2001). These changes are often anticipated by both adult and adolescent contraceptive users (Bancroft & Sartorius, 1990; Rosenthal, Cotton, Ready, Potter, & Succop, 2002). However, data linking hormonal contraceptive use to mood and sexual interest are inconsistent, have methodological limitations, and rarely address adolescent hormonal contraceptive users. The purpose of this study was to examine longitudinally associations of hormonal contraceptive use with mood and sexual interest among adolescents, addressing some of the methodological limitations of prior work.

Mood

Reviews of the adult literature report inconsistent effects of hormonal contraceptives on mood, with some studies demonstrating a negative effect, some a positive effect, and some well-designed and adequately powered studies demonstrating no effect (Bancroft & Sartorius, 1990; Kaunitz, 1999;

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Oinonen & Mazmanian, 2002; Slap, 1981). Studies of mood and depot medroxyprogesterone acetate (DMPA) use are similarly contradictory. An HMO-based observational study found lower levels of positive mood among DMPA users compared to barrier method users (Civic et al., 2000) whereas studies in other populations reported no association (Westhoff, 2003; Westhoff, Wieland, & Tiezzi, 1995).

Although adult studies often include older adolescent participants (over 16 or over 18 years), none specifically compare the adolescent and adult subgroups within the study. Studies of university students have found variable results (Oinonen & Mazmanian, 2001; Sanders et al., 2001). Sanders et al. compared women who continued OCP use to those that discontinued use, and found that emotional side effects, predominantly negative, were more common among discontinuers. Oinonen and Mazmanian (2001) compared OCP users to controls, and found no group differences in mean positive or negative mood between the two groups. A longitudinal study of 43 adolescents starting OCPs found that 30% of participants expected to experience mood symptoms, but few prospectively reported changes in mood during the study (Rosenthal et al., 2002). For adolescent DMPA use, one prospective study found no change in mood (Cromer, Smith, Blair, Dwyer, & Brown, 1994), but another study found less depression, compared to no change in controls (Gupta et al., 2001).

Adolescence is a time characterized by mood lability (Arnett, 1999; Compas, Ey, & Grant, 1993), with mood disruptions more likely to occur during middle adolescence than during other ages (Arnett, 1999). Mood states and mood variability, or changes in mood from day-to-day, are important to examine separately in an adolescent population. While a growing number of studies of adults identify changes in mood variability with contraceptive use, no studies of adolescents specifically examine this issue. In one retrospective study of 4,112 adult women, those taking OCPs reported fewer peaks and troughs of well being and sexual interest across their menstrual cycles (Warner & Bancroft, 1988). The specific type of OCP (monophasic vs. triphasic) may be important as well. In a study of mood variability across one cycle, women taking monophasic OCPs reported less variability than those taking triphasic OCPs or no OCPs (Oinonen & Mazmanian, 2001).

The relationship between mood level, mood variability, and hormones is additionally complicated by cyclic changes. Mood varies across the menstrual cycle (Sanders, Warner, Backstrom, & Bancroft, 1983) and, in adults, hormonal contraceptives may exert different influences at different points in the cycle. In a retrospective study, long term OCP users (>6 months) reported less menstrual phase mood variability compared to non-users (Bancroft & Rennie, 1993).

As with mood, variable relationships between hormonal contraceptives and sexual interest (or sexual desire) have been reported. A recent review of 30 research studies described inconsistent findings, with some reporting increased sexual interest, some decreased sexual interest, and some no change in sexual interest among OCP users, when compared to non-users of any hormonal methods (Davis & Castaño, 2004). As with mood, there may also be changes in variability, or the pattern and peaks, of sexual interest among OCP users compared to non-users (Warner & Bancroft, 1988).

Adolescent data clearly link sexual interest to sexual behaviors. In a daily diary analysis of sexual behavior of adolescent women by our group, higher levels of sexual interest on a given day was independently associated with increased likelihood of coitus on that day (Fortenberry et al., 2005). However, little is known about the impact of hormonal contraception on sexual interest among adolescents. In a single, uncontrolled study of 53 adolescent DMPA users, 15% reported decreased sexual desire (Matson, Henderson, & McGrath, 1997).

In addition to relatively little focus on adolescent users of hormonal contraceptive methods, current research has several additional methodological limitations. Many studies used retrospective reports and cross-sectional study designs, which may produce different data from prospective measurements. For example, two longitudinal studies of adult women found almost no differences in mood on prospective daily self-ratings, yet at the end of the study, participants reported retrospectively that mood was negatively affected (Graham, Ramos, Bancroft, Maglaya, & Farley, 1995; Oinonen & Mazmanian, 2001). Use of prospective measures, while more costly and time consuming, allow accurate parsing of mood into sub-components (e.g., positive mood, negative mood), as well as an examination of fluctuations in mood over time. The use of daily diaries, in particular, allows the investigator to examine day-to-day variation, and answer more accurately how hormonal contraceptives influence patterns of mood.

A second methodological limitation is that few studies examined both the positive and negative components of mood independently. Research suggests that an individual can have changes in one component without changes in the other (see, for example, Oinonen & Mazmanian, 2001). Final limitations are that no studies have addressed mood variability specifically among adolescent women, and few have examined the effects of OCPs on sexual interest among adolescent women.

The current study was designed to address these limitations. The purpose of this study was to evaluate longitudinally the effect of hormonal contraceptives on mood and sexual interest among adolescent women. Our first objective was to test for differences in positive mood, negative mood, and sexual interest by hormonal contraceptive method (no hormonal method, OCPs, DMPA). Our second objective was to test for differences in mood variability (or change over time) by hormonal contraceptive method. Our third objective was to examine whether stopping or starting OCPs was associated with mood and sexual interest changes.

Method

Participants

This study was embedded in a larger, longitudinal cohort study of risk and protective factors associated with STI among adolescent women. Participants were 14–17 years of age at enrollment, were recruited from three primary care adolescent clinics in a medium size midwestern U.S. city, and followed longitudinally for up to 41 months. The clinics serve communities characterized by high rates of poverty, early sexual onset, and sexually transmitted infections (Katz et al., 2001). Entry criteria included age, English fluency, and not currently pregnant. Current sexual activity, past sexual activity, and contraceptive use were not entry criteria to the larger study, as the purpose of the study was to longitudinally examine the development of sexual behaviors and STI across adolescence. Written informed consent was obtained from each participant and written permission was obtained from a parent or legal guardian for both participation in the study and for review of their medical records. This research was approved by the institutional review board of Indiana University Purdue University at Indianapolis—Clarian.

For these analyses, we used longitudinal data from 328 participants: 90% were African American, 8% white, and 2% other or multi-racial. Age range for the diary periods was 14.0–22.3 years, with a mean of 16.7 years (*SD*, 1.4 years).

Procedure

As part of the larger study, participants completed quarterly face-to-face interviews and provided up to seven, 3-month diary collection periods. Each diary collection period was initiated and terminated by a quarterly interview and was followed by a rest period of similar length in which no diary information was collected. Our primary unit of analysis was the 3-month diary period.

At the beginning of each diary period, participants were (re-)oriented to study procedures, received one week of blank diary sheets, and were asked to complete a single diary sheet at the end of each day. If an entry was forgotten, participants were asked to complete the form as soon as it was remembered. Field personnel collected completed diaries weekly and scanned them for completeness at that time. Participants received $2.00 for each completed diary as well as a bonus for completion of 80% of scheduled diaries. The diary instrument consisted of a single bar-coded, scannable sheet containing probes and response options. Participants responded to seven questions about daily mood and sexual interest and recorded whether or not a "birth control pill" was taken on a given day. Because these analyses were embedded in a larger ongoing observational cohort study, initiation of hormonal contraception may have been started at any point before, during, or after a diary period. In contrast to prospective trials, "time 0" represents the point where we started observing participants, rather than the initiation of the contraceptive method.

Measures

Positive Mood, Negative Mood, and Sexual Interest

Participants were asked to "Color the circle for each word that best describes how you felt today." The positive mood scale consisted of three items, ($\alpha = .87$, range 3–15) asking whether the participant had felt cheerful, happy or friendly (Fortenberry et al., 2005). The negative mood scale consisted of three items ($\alpha = .82$, range 3–15) asking whether the participant had felt irritable, angry or unhappy (Fortenberry et al., 2005). All mood and sexual interest items used a 5-point Likert-type response scale ranging from "not at all" to "all day." Sexual interest was measured by a single item with the above 5-point response scale, asking whether the participant was interested in having sex (Fortenberry et al., 2005). Positive and negative mood for first diary date per participant had a Pearson's correlation coefficient of −0.47. We created weekly mean positive mood, negative mood, and sexual interest scores. We chose to examine weekly periods as this was consistent with conceptualizations of menstrual cycle phases and previous research on mood, sexuality, and hormonal contraception (Bancroft & Rennie, 1993; Oinonen & Mazmanian, 2001; Warner, Bancroft, Dixson, & Hampson, 1991).

Hormonal Contraceptive Method Group

We classified 3-month diary periods as stable OCP use, non-use (of either OCPs or DMPA), initiated OCP use, stopped OCP use, and DMPA use based on self-report at quarterly interviews and medical chart abstraction. These categories of hormonal contraceptive method groups have been shown to be consistent with daily pill-taking behavior (Woods et al., 2006). We classified diary periods as stable OCP use if the participant reported OCP use in the interview at the beginning and end of the diary period, non-use if the participant reported no OCP use in either interview flanking the diary period and medical charts showed no use of DMPA during the diary period, initiated OCP use if the participant reported no OCP use at the beginning interview and OCP use at the end interview, and stopped OCP use if the participant reported OCP use at the beginning interview and no OCP use at the end interview.

DMPA use was abstracted from participants' medical charts. We classified 255 diary periods in which participants used DMPA across the entire diary period as DMPA. We excluded diary periods where a participant changed methods during the diary period or used DMPA for only part of the diary period. If a participant used a consistent method within a diary period, but changed methods from one diary period to the next (i.e., non-use to stable OCP use), that participant could contribute diary periods to two different use groups. This non-independence was accounted for in the statistical analysis.

We started with 1,154 diary periods. We excluded five diary periods where the beginning interview was missing, excluded 143 diary periods where the participant switched methods during the diary period or used DMPA for only part of the diary period, and excluded 68 diary periods in which the participant was pregnant, leaving 938 diary periods. For 18 of the 938 diary periods, the response to the interview question about OCP use was missing; for 140 of the diary periods, the ending interview was missing (i.e., the participant did not come in for an interview that quarter). For these 158 diary periods with missing responses, we used the nearest three diary days to impute OCP use. We did sensitivity analyses for this imputation using 5, 3, and 2 days, and found similar labels and estimates of means among the imputations. While we did not specifically ask OCP formulation, the most commonly prescribed OCPs in the clinics where we recruited patients were monophasic Norgestimate/35 mcg Ethinyl Estradiol and Desogesterel/30 mcg Ethinyl Estradiol OCPs.

Weekly Pill Taking Behavior

To further examine whether mood changes with initiation and cessation of OCPs, we examined mood in conjunction with weekly pill taking behavior. Participants recorded daily pill taking on diaries. To evaluate diary periods when participants stopped or initiated pills, we collapsed that information into weeks on OCPs ($\geq$0 pills/week) and weeks off OCPs (=0 pills/week).

Data Analysis

Our primary unit of analysis was the diary period; individual participants could contribute multiple diary periods. We chose the diary period, rather than the participant, as the unit of analysis, because this better reflects an individual participant's mood fluctuation and on and off contraceptive use. Adolescents frequently change methods, and because an individual participant may have used several methods across the 3-½ year period of observation, it was inappropriate to categorize an individual adolescent as a "pill user" or "DMPA user." Use across a 3-month period was generally stable, so that we could categorize behavior during diary periods by method used. Using the diary period as the unit of analysis and linear mixed effects models allowed us to use a "within-subject" rather than a "between subjects" approach, examining the associations between different hormonal contraceptive methods and mood within individual participants.

To test our first objective of examining how mood and sexual interest vary by contraceptive method group, we modeled average weekly positive mood, average weekly negative mood, and average weekly sexual feelings separately, using linear mixed effects models with a random intercept and random slope across weeks in a diary period, a fixed effect for hormonal contraceptive method group and an effect for age at the start of a diary period. Mixed effects models include additional random effects terms to account for clustered data. In this model, the random intercept and slope were chosen to accommodate multiple diary periods contributed by the one participant, as well as multiple weekly responses from one participant within each diary period. The estimates for hormonal method group could then be interpreted as the average effect of each method on weekly mood, adjusted for the subject-specific mean weekly mood and the subject-specific change in average mood. To control for Type 1 error, comparisons of least square mean weekly mood between hormonal contraception method groups were adjusted using a Tukey–Kramer adjustment (Kramer, 1956). SAS v9.1 PROC MIXED procedure was used for the analysis.

To test our second objective of examining differences in mood changes (or mood variation) among different hormonal contraceptive groups, we used similar models to objective 1 above for the *SD* of weekly positive mood and the *SD* of weekly negative mood. We selected the *SD* of weekly mood as a measure of the degree of day-to-day variation in mood across the week, based on the literature (Oinonen & Mazmanian, 2001). Participants with greater day to day mood fluctuation across a week will have a larger *SD*.

To test our third objective, we compared mood and sexual interest during weeks on and off pills in diary periods in which participants stopped or initiated OCP use. We modeled mean weekly positive mood, negative mood, and sexual interest using a mixed model with a fixed effect for OCP use in that week (off or on OCPs) and random intercept and slope.

Results

Diary Period Completion and Contraceptive Method Use

Of the 328 participants, each contributed, on average, 2.9 ($SD = 1.6$) diary periods, for a total of 938 diary periods

analyzed. We classified 115 (12%) of diary periods as stable OCP use, 29 (3%) as initiating OCPs, 52 (6%) as stopping OCPs, 255 (27%) as DMPA, and 487 (52%) as non-use of either hormonal method. Participants had a mean age of 16.7 years ($SD = 1.4$) at the start of each diary period.

Mood and Sexual Interest by Hormonal Contraceptive Method

To assess whether mood and sexual interest differed by contraceptive method, we first examined differences in mean weekly positive mood in a diary period by hormonal contraceptive group adjusted for age and time from the start of the diary period. During diary periods characterized by stable OCP use, participants reported significantly higher mean weekly positive mood compared to periods of non-use, initiating OCP use, or DMPA use. See Table 1, Model 1 for adjusted means and SEMs, and Table 2, Model 1, for contrasts. Older age at the start of the 3-month diary period was associated with greater positive mood ($\beta = .085$, SE = .024, $p < .001$); however, there was no evidence of temporal change in mean weekly positive mood across the diary period ($\beta = -.005$, SE = .005).

We then examined differences in mean weekly negative mood among hormonal contraceptive groups, also adjusted for age and time. During diary periods characterized by stable OCP use, participants reported significantly lower mean weekly negative mood compared to periods of non-use, initiating OCP use, or DMPA use. During diary periods characterized by DMPA use, participants reported significantly higher mean weekly negative mood compared to periods of non-use. See Table 1, Model 2 for adjusted means and SEMs, and Table 2, Model 2 for significant contrasts among hormonal contraceptive method groups. Mean weekly negative mood did not change significantly by age at the start of the 3-month diary period ($\beta = -.035$, SE = .02), or by time across the diary period ($\beta = .006$, SE = .006).

Finally, we examined differences in weekly sexual interest by hormonal contraceptive group, adjusted for age and time (see Model 3, Table 1). No comparisons among contraceptive methods were significant. Older age at the start of the diary period was associated with increased sexual interest ($\beta = .023$, SE = .008, $p < .01$). However, mean weekly

Table 1 Mean weekly mood, mean weekly sexual interest, and weekly mood variation by hormonal contraceptive method

Hormonal contraceptive use groups	Model 1: Positive mood[a]		Model 2: Negative mood[a]		Model 3: Sexual interest[c]		Model 4: *SD* of positive mood[a]		Model 5: *SD* of negative mood[a]	
	Adjusted *M*[b]	SEM	Adjusted *M*[b]	SEM	Adjusted *M*[b]	SEM	Adjusted estimate[b]	SE	Adjusted estimate[b]	SE
Non-use	9.16	.16	5.60	.10	1.61	.04	1.84	.05	1.60	.05
Stable OCP use	9.55	.17	5.38	.12	1.63	.05	1.70	.07	1.42	.06
Initiating	9.02	.20	5.83	.14	1.70	.06	1.91	.09	1.65	.09
Stopping	9.30	.18	5.56	.13	1.69	.05	1.87	.08	1.53	.07
DMPA	9.18	.16	5.79	.11	1.62	.05	1.81	.06	1.68	.05

[a] Three-item scales, range 3–15

[b] Weekly mean adjusted for age, using linear multi-level models with a subject specific slope and intercept

[c] Single item, range 1–5

Table 2 Significant contrasts for models of mean weekly mood, mean weekly sexual interest, and weekly mood variation

Contrasts among hormonal contraceptive method groups[a]	*p*-value				
	Model 1: Positive mood[b]	Model 2: Negative mood[b]	Model 3: Sexual interest[b]	Model 4: *SD* of positive mood[b]	Model 5: *SD* of negative mood[b]
Stable use vs. Non-use	<.001	<.05	ns	ns	<.01
Stable use vs. Initiating	<.01	.001	ns	ns	<.05
Stable use vs. DMPA	<.01	<.001	ns	ns	<.001
Non-use vs. DMPA	ns	<.05	ns	ns	ns

[a] Contrasts that did not reach significance were not included in the table

[b] Linear multi-level models with a subject specific slope and intercept adjusted for age

sexual interest did not change significantly across the 3-month diary period ($\beta = -.0002$, SE = .002).

Variation in Mood by Hormonal Contraceptive Method

To assess whether day-to-day variations in mood differed by contraceptive method, we first examined differences in the *SD* of weekly positive mood by hormonal contraceptive group. For variation in positive mood, we found no associations between the *SD* of weekly positive mood and hormonal contraceptive group (see Model 4, Table 1). For all groups, the *SD* of weekly positive mood, or the variation in daily mood across the week, significantly decreased with age of the participant ($\beta = -.20$, SE = .14, $p < .001$), and as weeks progressed during the 3-month diary period ($\beta = -.039$, SE = .004, $p < .001$).

We then examined differences in the *SD* of weekly negative mood by hormonal contraceptive group (see Model 5, Table 1). During diary periods characterized by stable OCP use, participants reported significantly smaller *SD*, or less variation, of weekly negative mood compared to periods of non-use, initiating OCP use, and DMPA use. For all groups, the *SD* of weekly negative mood, or variation in daily negative mood across the week, decreased with age ($\beta = -.12$, SE = .01, $p < .001$), and decreased as weeks progressed during the 3-month diary period ($\beta = -.023$, SE = .003, $p < .001$).

Mood and Sexual Interest Changes when Initiating or Stopping OCPs

To test our third objective, to determine if mood changes were related to stopping and initiating OCPs, we modeled mean weekly mood and sexual interest during weeks on and off OCPs (see Table 3). We limited our first set of analyses to diary periods characterized by initiating OCPs, and examined positive mood, negative mood, and sexual interest separately. During diary periods characterized by initiating OCPs, participants' mean weekly positive mood was significantly higher in weeks off OCPs than in weeks on OCPs (see Model 1, Table 3). Mean negative mood and mean sexual interest were not significantly different between weeks on OCPs compared to weeks off OCPs (see Models 2–3, Table 3).

We then conducted a similar set of analyses limited to diary periods characterized by stopping OCPs. During these diary periods, participants reported significantly higher mean weekly positive mood and significantly lower mean weekly negative mood and significantly higher mean sexual interest during weeks on OCPs, compared to weeks off OCPs (see Models 4–6, Table 3).

Table 3 Differences in weekly mood and sexual interest during weeks off and on OCPs during periods of OCP initiation and OCP stopping

	Adjusted M^a	SEM
Initiating OCPs		
Model 1: Weekly positive mood		
Off OCPs	9.25**	.64
On OCPs	8.40	.64
Model 2: Weekly negative mood		
Off OCPs	5.16	.32
On OCPs	5.12	.32
Model 3: Weekly sexual interest		
Off OCPs	1.94	.23
On OCPs	1.90	.23
Stopping OCPs		
Model 4: Weekly positive mood		
Off OCPs	9.13**	.43
On OCPs	9.76	.44
Model 5: Weekly negative mood		
Off OCPs	5.88**	.27
On OCPs	5.43	.29
Model 6: Weekly sexual interest		
Off OCPs	1.63*	.13
On OCPs	1.77	.13

[a] Weekly mean using linear multi-level models with a subject specific slope and intercept

* $p < .05$, ** $p < .01$, *** $p < .001$

Discussion

Three key findings from this study deepened our understanding of adolescent girl's mood and sexual interest within the context of hormonal contraceptive use. First, hormonal contraception was associated with prospective changes in mood. The division of mood into positive and negative components allowed us to tease out specifically where hormonal contraceptives acted. Positive mood was higher and negative mood was lower during periods characterized by a high level of OCP use. These differences were in comparison to OCP users with less intense OCP exposure (i.e., those who either started or stopped OCP use during a given period) or among those with no OCP use at all. The one exception was our analysis of the 29 diary periods in which OCPs were initiated-participants reported lower levels of positive mood in the weeks after initiation of OCPs. This may be due directly to the hormonal effects of OCPs. Adolescents with strong negative mood effects from OCPs would be likely to initiate OCPs but unlikely to continue OCPs. However, we were cautious in our interpretation of results based upon only 29 diary periods. The weight of our results suggested that strong clinical concerns about deleterious effect of OCP on mood may be misplaced, and that

depressed mood may not be as important a relative contraindication to OCP use among adolescents compared to other populations (Hatcher et al., 2004).

Second, the direction and type of changes differed for OCP and DMPA. Compared to periods of non-use, diary periods with DMPA use showed higher levels of negative mood but no difference in positive mood. This increase in negative mood was consistent with adult clinical guidelines (Hatcher et al., 2004), although adult DMPA research shows varied results (Civic et al., 2000; Westhoff, 2003; Westhoff et al., 1995). Our finding suggested that, among adolescents, increased attention should be given to potential negative mood increases associated with DMPA use, especially if these changes in negative mood are linked to other adverse outcomes, such as weight gain.

Third, the use of a daily, multidimensional measure allowed us to examine differences in weekly mood variation. The use of daily, prospective diaries allowed us to represent day-to-day fluctuations in mood, and to decrease recall bias. We found differences in mood variability, as modeled by the variance of weekly mood, among diary periods characterized by different hormonal contraceptives. Specifically, OCP use was associated with less variability in negative mood. This was consistent with a review of the adult literature which showed that oral contraceptives appeared to provide a stabilizing influence on mood (Oinonen & Mazmanian, 2002). We note that decreased mood variability could be perceived to be an improvement (i.e., with women who report premenstrual syndrome), or to be detrimental (i.e., if someone felt more "flat"). Decreased mood variability may explain the literature's contradictory findings of the effect of OCPs on mood, as well as the discrepancy between prospective reports of only small quantitative differences in mood and retrospective reports of significant mood changes among the same women in the same study (Graham et al., 1995).

When we examined temporal changes across the 3-month diary period, none of the groups (OCP users, non-users, initiators, stoppers, and DMPA users) evidenced significant changes in mean weekly positive mood, mean weekly negative mood, or mean sexual interest. This was not unexpected, as 3 months is a short time period. We did, however, find that all groups showed a significant temporal decrease in variation in daily positive and negative mood across the 3-month diary period. Our findings of decreased temporal variability may be due to adaptation to the hormones themselves. No clear consensus exists as to the biochemical mechanisms for the effects of estrogens and progestins on mood. However, potential mechanisms for changes in mood require time for up-regulation or down-regulation of neuroendocrine receptors, and as well as increases or decreases in relevant biochemical intermediaries in serotonin and other pathways (Oinonen & Mazmanian, 2002). Alternatively, this temporal association may represent a methodologic issue such as diary fatigue. While overall compliance with diaries in the study was high (average daily completion rate over 80%), it is possible that diaries filled out later during the diary period were completed with less attention and care. Field procedures (weekly visits by field staff to pick up and drop off diary packets) limited missing data later during diary periods.

We found no associations between hormonal contraceptive use and sexual interest. It is possible that hormonal effects were less influential on sexual interest than behavioral factors, such as relationship quality. Alternatively, a single item measure may not have been sufficiently sensitive to capture a complex construct like sexual interest or variations in sexual interest across a single day may not have been easily summarized at a single point in time. A second alternative is that we may have found no significant effects, even with a more robust measure. Studies of young women have found that many have difficulty articulating sexual desire (Tolman, 2002).

The primary methodological limitation of the study was its observational design; without randomization, we were unable to assess the direction of the relationship between mood and OCP use. Because participants selected their own contraceptive method, it was likely that there were unobserved differences among groups that may contribute to findings (i.e., adolescents who chose a daily pill may have been more organized or had greater internal locus of control, compared to those that chose a quarterly injection). However, randomized controlled trials comparing highly effective contraceptives to placebo or to less effective methods are ethically problematic among young women at high risk for pregnancy. A second design limitation was that, although participants were instructed to fill out diaries daily, it was possible that some filled out a week of diaries on the day of the weekly project staff visits. To the extent that this occurred, it would decrease variability. A third limitation was the 3-month length of the diary period. While short, it was consistent with the length of time young women typically use a contraceptive method before switching or discontinuing (Furstenberg, Shea, Allison, Herceg-Baron, & Webb, 1983; Grady, Billy, & Klepinger, 2002).

A final limitation is that relationship status might have confounded the associations between hormonal contraceptive use and mood. This may explain the apparently contradictory results in our sub-analyses of weekly mood during periods of initiating and stopping OCPs. During periods of initiation, we found that mood was higher before starting OCPs. In contrast, during periods of stopping, we found mood higher before stopping, while still on OCPs. However, if a change in contraceptive method is a marker for a change in a relationship, then these results might be consistent, and represent higher mood before a relationship change, rather than a direct effect of hormonal contraceptives on mood.

For example, if the initiation of OCPs were coincidental with the initiation of a sexual relationship, the lower positive mood in weeks after OCP initiation might have represented relationship tensions. Alternatively, more effective contraception may also have been initiated because of a change in some other aspect of the relationship that is related to mood, such as a decrease in relationship quality or trust. A young woman who previously might not have minded becoming pregnant with a particular partner now did not want to become pregnant with that partner. The stopping of OCPs might represent the dissolution of a relationship, with the resulting increase in negative mood after stopping OCPs due to the relationship change, rather than a direct result of the hormonal contraceptive.

This study provided new insights into the relationship between mood, sexual interest, and hormonal contraception among adolescents. Our data suggested that adolescent sexual activity occurs, at least to some degree, in response to internal motivations. A more complete understanding of adolescent sexuality and sexual behavior thus requires more detailed understanding of factors that may influence sexual interest as one of those key internal motivations (Smiler, Ward, Caruthers, & Merriwether, 2005). We addressed some of the methodological limitations of previous research, including a longitudinal design to reduce recall bias, parsing mood into its positive and negative components, and using a daily measure to capture variability as well as direction and intensity of mood.

Our findings of changes in mood and sexual interest with OCP and DMPA use have implications for contraceptive adherence. Clinicians may be able to predict, and potentially prevent, the discontinuation of effective contraception by carefully assessing and addressing the positive and negative effects of hormonal contraception on mood and sexual interest.

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