Contraceptive Satisfaction but not Sexual Satisfaction or Sexual Frequency Predicts Contraceptive Switches

Chiara N. Draxler[a,*], Ruben C. Arslan[b], Lars Penke[a,c], and Laura J. Botzet[a,c]

[a]Biological Personality Psychology, University of Goettingen, Goettingen, Germany
[b]Department of Psychology, University of Leipzig, Leipzig, Germany
[c]Leibniz ScienceCampus Primate Cognition, Goettingen, Germany

ORCIDs:

- Chiara N. Draxler: https://orcid.org/0000-0002-9958-7440
- Ruben C. Arslan: https://orcid.org/0000-0002-6670-5658
- Lars Penke: https://orcid.org/0000-0002-9484-580X
- Laura J. Botzet: https://orcid.org/0000-0001-5765-8354

Total word count submitted manuscript: 13,083 words

*Corresponding author:
Chiara N. Draxler
Biological Personality Psychology, Institute of Psychology
Goßlerstraße 14, 37073 Goettingen, Germany
Email: chiara.na.draxler@gmail.com

Abstract

Estimates of the causal effects of hormonal contraceptives on psychological outcomes are likely distorted by contraceptive discontinuation (including starting or stopping a method and switching between methods) because of side effects. Few studies examine contraceptive discontinuation and most are based on correlational cross-sectional data. The literature suggests method- and sexuality-related variables as predictors of contraceptive discontinuation. The current study therefore analyzed type of contraceptive method, contraceptive satisfaction and usage duration, as well as sexual frequency and sexual satisfaction as predictors of contraceptive switches, which is one form of contraceptive discontinuation. In addition, we examined the sensitivity of the reported effects to unobserved selection effects. Analyses were based on longitudinal data from the *Continuity and Change in Contraceptive Use Study* with a sample of up to 1,993 women. We found substantial and robust effects of contraceptive method and contraceptive satisfaction on contraceptive switches, but no clear evidence on interaction effects between contraceptive method and contraceptive satisfaction. Furthermore, we found no effects of sexual satisfaction or frequency across all analyses.

Keywords: contraception, discontinuation, longitudinal data, sexual satisfaction, sexual frequency

Supporting material to this manuscript, including all code for the data-wrangling processes, the analyses, as well as the figures, can be found on the Open Science Framework: https://osf.io/nqtup/ or on the github project: https://GitHub.com/chiaradraxler/hc_switch_cccu

Contraceptive Satisfaction but not Sexual Satisfaction or Sexual Frequency Predicts Contraceptive Switches

In 2019, more than 900 million women[1] aged 15 to 49 years or their partners worldwide were using some form of contraceptive method. The decision about which contraceptive method to use is an intimate one for many couples and depends on individual demands and priorities across the lifespan (Both et al., 2019). Some couples choose non-hormonal contraceptive methods such as male or female condoms, diaphragms, withdrawal, natural and chemical forms of contraception, copper intrauterine devices (IUDs) and sterilization. Other couples choose hormonal contraceptive methods such as oral contraceptives (i.e., the birth control pill), hormonal IUDs, depot injections, subdermal implants, vaginal rings, and hormonal patches. Reliability, practicability, potential positive and negative side effects, habits, partner preferences, doctor's recommendations, and costs play an important role in deciding which contraceptive method to use (based on data from Germany; Bundeszentrale für gesundheitliche Aufklärung, 2011).

Since the invention of oral contraceptives in the 1960s, research on hormonal contraceptives has made progress in reducing hormonal concentrations and negative side effects while maintaining reliability (Bitzer & Simon, 2011). According to Both et al. (2019), hormonal contraception contributed to women’s sexual liberation via the “separation of sexuality from procreation” and thereby allowed women to focus on pleasure while having control over family planning (Baird & Glasier, 1993; Fraser, 1986; Le Guen et al., 2021). However, in recent years women are increasingly discussing negative side effects. Concerns include effects on menstruation (e.g., heavy flow), physical side effects (e.g., increased hunger), mental health effects (e.g., mood swings,) and effects on sexuality (e.g., decreased

[1] By women in this context of hormonal contraceptive use research, we are referring to biologically female individuals, i.e., individuals with developed ovaries, as this biological characteristic is central to their endocrine system. The current study is based on a data set including only women at risk of pregnancy.

libido), alongside concerns about future fertility or a wish to use more natural methods (Le Guen et al., 2021). Such concerns lead many women to discontinue or switch their contraceptive method. Khan et al. (2007) report discontinuation[2] rates of 19% to 36% and switching rates of 40% to 89% for all contraceptives in a five-year longitudinal study in North Africa, South Asia and Latin America. For hormonal contraceptives, Hooper (2010) found in a multi-national sample of over 5,000 women that discontinuation rates ranged from 22% in Germany to 79% in Brazil. Ali and Cleland (2010) found discontinuation rates of 28% for oral contraceptives, the third highest rate after injectables and condoms in their analysis of 23 countries (Armenia to Zimbabwe) from 1990 to 2008.

Because some concerns about side effect are specific to hormonal contraception, we expect contraceptive switches to differ depending on the current method[3]. The goal of the current study was to understand why women switch their contraceptive method using the longitudinal sample of the *Continuity and Change in Contraceptive Use Study* (CCCU) by Jones (2018a). We focused on the switch between hormonal and non-hormonal methods[4]. Studying patterns of contraceptive use is important not only because of the relatively large research gap (e.g., Littlejohn, 2012; Villavicencio & Allen, 2016), but also because of the potential consequences arising out of discontinuation, such as unplanned pregnancies or abortions (e.g., Barden-O’Fallon & Speizer, 2011; Vaughan et al., 2008).

[2] In this study, we use the term contraceptive discontinuation to refer to the absence of contraceptive continuation (sometimes also used as contraceptive (dis)continuity).

[3] For contraceptive methods, the terms discontinuation (or discontinuity) and switching reflect two different constructs and the literature often clearly distinguishes the two. Whereas discontinuation describes stopping to use contraceptives and can be an active (e.g., removing IUD) or passive (e.g., missed re-injection) process, switching refers to a switch from one contraceptive method to another (Barden-O’Fallon & Speizer, 2011). In the current study we only describe switching behavior (i.e., the current study does not include women who stop a contraceptive method but do not switch to another method and women who start using a contraceptive method but used no contraceptive method before).

[4] In the following, when we refer to the group of non-hormonal contraceptive users, this does not include women using *no* contraceptive method. In addition, switches within the groups of hormonal contraceptive users or within non-hormonal contraceptive users were not counted as switches.

In the following, we distinguish between method-related variables and sexuality-related variables as predictors of contraceptive switches. Method-related predictors include type of contraceptive method, contraceptive satisfaction, and contraceptive duration. Sexuality-related predictors include sexual frequency and sexual satisfaction.

Method-Related Predictors of Contraceptive Switches

Type of Contraceptive Method

Hormonal contraceptives are frequently perceived as having more side effects due to their influence on systemic endocrine pathways. Women often discontinue their contraception because of perceived side effects (Barden-O'Fallon & Speizer, 2011). Therefore, we expected hormonal contraceptive users to be more likely to switch methods.

Hypothesis 1: The probability to switch will be lower for women that used non-hormonal contraceptives relative to women that used hormonal contraceptives.

Note that an overview of the specified hypotheses and their operationalizations can be found in Table S1 in the supplemental material A.

Contraceptive Satisfaction

Moreau et al. (2007) investigated contraceptive dissatisfaction in a sample of more than 6,000 women aged 15 to 44 years. They discovered that 46% of all users of reversible contraceptives had discontinued at least once because of dissatisfaction. Littlejohn (2012) reported comparable rates of discontinuation for hormonal contraceptive users. Furthermore, Frost et al. (2007) discovered in a nationally representative sample of 1,978 women aged 18 to 44 years that contraceptive dissatisfaction predicted gaps in contraceptive behavior and switching contraceptive methods. Finally, Peipert et al. (2011) observed that copper and hormonal IUD users were more satisfied with their contraceptive method, resulting in higher continuation rates compared to oral contraceptive users.

Side effects are the major cause of dissatisfaction (Fathizadeh et al., 2011; Littlejohn, 2012; Peipert et al., 2011; Villavicencio & Allen, 2016). Therefore, we expected that women's satisfaction with their method is negatively associated with contraceptive switches, particularly for hormonal contraceptive users:

Hypothesis 2: The probability to switch will be higher for women that were less satisfied with their contraceptive method relative to women who were more satisfied with it.

Hypothesis 3: This effect will be stronger for women that used hormonal contraceptives relative to women that used non-hormonal contraceptives.

Contraceptive Duration: Sub Analyses for Hormonal Contraceptive Users

The longer a woman has been using a certain contraceptive, the longer we might expect her to continue doing so. Unfortunately, the CCCU (Jones, 2018a) did not collect data about contraceptive duration for non-hormonal contraceptives, thus data about contraceptive duration is only available for hormonal contraceptive users. Consequently, we examined contraceptive duration only for hormonal users in a sub analysis. All pertinent details for sub analyses, including the theory and hypotheses, methods, analyses and results as well as figures and tables, are available in Supplement B in the supplemental material.

Sexuality-Related Variables as Predictors of Contraceptive Switches

Sexual Frequency and Sexual Satisfaction

In addition to method-related reasons, other factors may be responsible for contraceptive switches, for example, sexuality. In general, there is a gap in research that incorporates sexuality into contraceptive use patterns (Higgins & Hirsch, 2008; Welling, 2013). As noted by Inoue et al. (2015), contraceptive use is directly related to sexual behavior. Thus, contraceptive use patterns might affect sexuality-related variables, and vice versa. Following the randomized placebo-controlled trial study from Zethraeus et al. (2016), hormonal contraception decreases sexual desire and satisfaction. The correlational cross-sectional study of Malmborg et al. (2015) reported that hormonal contraceptive users were more likely to experience a decrease in sexual desire, which in turn was associated with plans to discontinue the method. Furthermore, the correlational cross-sectional study of Ersek et al. (2010) found that lack of sexual intercourse was the primary reason for contraceptive discontinuation. According to the correlational longitudinal study of Kerns et al. (2003), less sexual frequency predicted a higher likelihood of discontinuation.

According to the empirical evidence reviewed above, the following is expected for sexual satisfaction and sexual frequency[5]:

Hypothesis 4: The effect of contraceptive satisfaction at previous wave (i.e., six months earlier) on probability to switch will be unaffected by the inclusion of sexual satisfaction and sexual frequency at previous wave and their interaction with hormonal contraceptive use at previous wave.

Hypothesis 5: The interaction of contraceptive satisfaction with hormonal contraception at previous wave will be unaffected by the inclusion of sexual satisfaction and sexual frequency at previous wave and their interaction with hormonal contraceptive use at previous wave.

[5] Besides estimating the effects of sexual satisfaction and sexual frequency in a combined model with contraceptive satisfaction, we estimated the effects of sexual satisfaction and sexual frequency separately without controlling for contraceptive satisfaction.

Hypothesis 6: The probability to switch will be higher for women that were less sexually satisfied relative to women who were more sexually satisfied.

Hypothesis 7: This effect will be stronger for women that used hormonal contraceptives relative to women that used non-hormonal contraceptives.

Hypothesis 8: The probability to switch will be higher for women that had less frequent sexual intercourse relative to women with a higher frequency.

Hypothesis 9: This effect will be stronger for women that used hormonal contraceptives relative to women that used non-hormonal contraceptives.

Sensitivity to Observed and Unobserved Confounders

Women do not randomly select their contraceptive method. To establish causal inferences, it is essential to consider potential confounding selection variables, with demographic variables as well as attitudes appearing to be important confounders. The literature indicates that various selection variables may be associated with contraceptive use and discontinuation, including age (e.g., Blanc et al., 2009; Kerns et al., 2003), income (Ali & Cleland, 2010), insurance status (Frost et al., 2007; Vaughan et al., 2008), educational degree (e.g., Ali & Cleland, 2010; Frost et al., 2007; Littlejohn, 2012; Moreau et al., 2013; Simmons et al., 2019), relationship status (e.g., Moreau et al., 2013; Vaughan et al., 2008), relationship duration (e.g., Frost et al. 2007; Higgins et al., 2008; but see Botzet et al., 2021, for a discussion about whether to include relationship duration), number of children (Belete et al., 2018; Vaughan et al., 2008), and pregnancy attitudes (Simmons et al., 2019).

We adjusted for the following variables to see if main effects are unaffected by observed confounders: age, educational degree, poverty rating, health and medical problems, gaps in insurance and coverage by insurance, number of kids, if women were pregnant and had a baby between measurement occasions, pregnancy avoidance and pregnancy feelings (i.e., happiness about a pregnancy) and relationship duration. The following is expected:

Hypothesis 10 to 15: Hypothesis 4 through 9 will be robust to the inclusion of the above-mentioned selection variables at the previous wave and their interaction with hormonal contraceptive use at the previous wave.

Furthermore, we planned to estimate the effects' sensitivity to unobserved confounders, if the effects were robust to observed confounding.

Previous Research: Contraceptive Discontinuation in Cross-Sectional Studies

Most of the studies reviewed in the preceding sections were cross-sectional (Le Guen et al., 2021; Littlejohn, 2012). In such studies, contraceptive discontinuation because of negative effects on the outcome of interest might mask causal effects of hormonal contraception on psychological outcomes (see Botzet et al., 2021; denoted as "attrition effects"). Women who have negative experiences with hormonal contraceptives (e.g., because of side effects) are more inclined to discontinue them. In a cross-sectional study, women may have already self-assorted to their personally optimal contraception to some degree, leading to better outcomes in the group of hormonal contraceptive users (if the remaining users mainly experienced positive side effects) or no difference between groups. Consequently, differences in psychological outcomes between contraceptive methods might be underestimated. In our longitudinal study, we can directly investigate this mechanism of contraceptive discontinuation due to lower sexual frequency or sexual satisfaction.

Addressing Contraceptive Discontinuation in Longitudinal Studies

In the current study, our primary focus is causal inference, specifically to elucidate distorting effects due to contraceptive discontinuation. While longitudinal studies are often touted for their potential to establish causality, it is essential to recognize their limitations. Rohrer (2019) points out that longitudinal analyses cannot be treated as “magical causal inference machines.” Despite their ability to rule out certain potential explanations such as between-subjects confounding and reverse causality, they do not automatically guarantee a causal effect. The presence of confounding third variables, especially time-varying within-subject confounders, remains a challenge. Building on the recommendations of Rohrer (2019) and Rohrer and Lucas (2020), our contribution is to increase the transparency of causal assumptions in longitudinal analyses. In addition, we emphasize the need to specifically address contraceptive discontinuation. To achieve this, we advocate the use of coherent frameworks and providing comprehensive lists of potential confounders. In doing so, we aim to advance future research in the field, provide a nuanced understanding of causal inference in the field of hormonal contraceptive research and shed light on the intricacies of contraceptive discontinuation.

The Current Study

We analyzed longitudinal data from the CCCU (Jones, 2018a) that encompassed 1,993 women for our main analyses. The primary objective of this study was to gain a better understanding of how contraceptive discontinuation (in particular switches in contraceptive methods) because of hormonal side effects on sexuality can bias estimated effects of hormonal contraceptives on sexuality. To answer this question we estimated effects of method-related predictors, such as type of contraceptive method, contraceptive duration (see supplement B in the supplementary material for sub analyses), and contraceptive satisfaction, as well as effects of sexuality-related variables, such as sexual frequency and sexual satisfaction, on contraceptive switches. In addition, we determined whether effects remain unaffected by the inclusion of observed confounding selection variables. Furthermore, this study quantitatively estimated the sensitivity of effects to unobserved confounding selection variables. Lastly, this study checked the robustness of effects when excluding potentially distorting participants from a subsample.

Methods

Sample and Procedure

This project is based on pre-existing data from the CCCU by Jones (2018a). General summary information about the study and the data can be found at this link: https://www.icpsr.umich.edu/web/ICPSR/studies/37067/summary.

The sample of the CCCU by Jones (2018a) is based on the KnowledgePanel (Jones, 2018b) of the Growth from Knowledge group with approximately 60,000 members that were recruited through address-based sampling[6] (Jones, 2018b). Through a series of mailings, potential members are invited to join the KnowledgePanel. Registered members can then participate in eligible surveys once a week. Demographic and personal information is collected from all KnowledgePanel members (Jones, 2018b).

The CCCU by Jones (2018a), which was approved by the Guttmacher Institute's federally registered institutional review board, measured a wide range of contraceptive use patterns as well as information about fertility, health, and women's partner(s) within four survey waves. All relevant variables for the current study are derived from the four waves. The study type of the CCCU was an observational longitudinal study. The study design was a repeated measures within-subjects design, with measures nested within participants.

The CCCU was conducted from 2012 to 2014 with six months between each wave. The first wave was conducted over three weeks between November and December 2012 (T_1) followed by the second wave was conducted over three weeks between May and June 2013 (T_2). Women responded to the third wave in December 2013 (T_3) and to the final wave in June 2014 (T_4)[7]. For the CCCU, women were eligible if they were between 18 and 39 years

[6] The address-based samples are selected via four strata: Hispanic households with at least one person aged 18 to 24 years, remaining Hispanic households, remaining households with at least one person aged 18 to 24 years, and finally remaining households (Jones, 2018b).

[7] Note that for T_4, only the outcome switch was used in the current study, as there was no T_5 for which a switch could have been predicted. T_4 measurement occasions were thus not incorporated in the further analyses, figures and graphs, except for information about the switch from T_3 to T_4.

old, had already had sexual intercourse, were not currently pregnant, and had no tubal ligation. In addition, participants' romantic partners were required to have no vasectomy (these will be referred to as *eligibility criteria*).

At the outset of the CCCU, women were screened for risk of pregnancy following the study's eligibility criteria. Those who met the criteria were invited to take part in the four study waves. The study material included four surveys, one for each wave, which were conducted entirely online. Participants who lacked internet access were granted access by the Growth from Knowledge group. The surveys were available in both English and Spanish language. The median survey completion time was 12 minutes. Participants received $10 for each completed wave (Jones, 2018b).

A flow chart detailing the recruitment process for the CCCU, beginning with the study's invitation and ending with the last wave T_4, can be found in Figure S3 in the supplemental material C. Out of the N = 11,365 women invited to participate, N = 6,658 responded, resulting in a 41% response rate. After excluding ineligible participants, a total of N = 4,647 were deemed eligible, of whom N = 4,634 completed the initial survey at T_1. Subsequently, all women that completed the survey at T_1 were asked to participate in the following three waves. N = 3,207 women (69% of T_1) participated at T_2, N = 2,398 at T_3 (52% of T_1) and finally N = 1,842 women (40% of T_1) participated at T_4. This results in 7,448 measurement occasions *between* waves and therefore a potential switch in contraceptive methods. It should be noted that this number will decrease further across analyses based on the exclusion criteria specific to the research question.

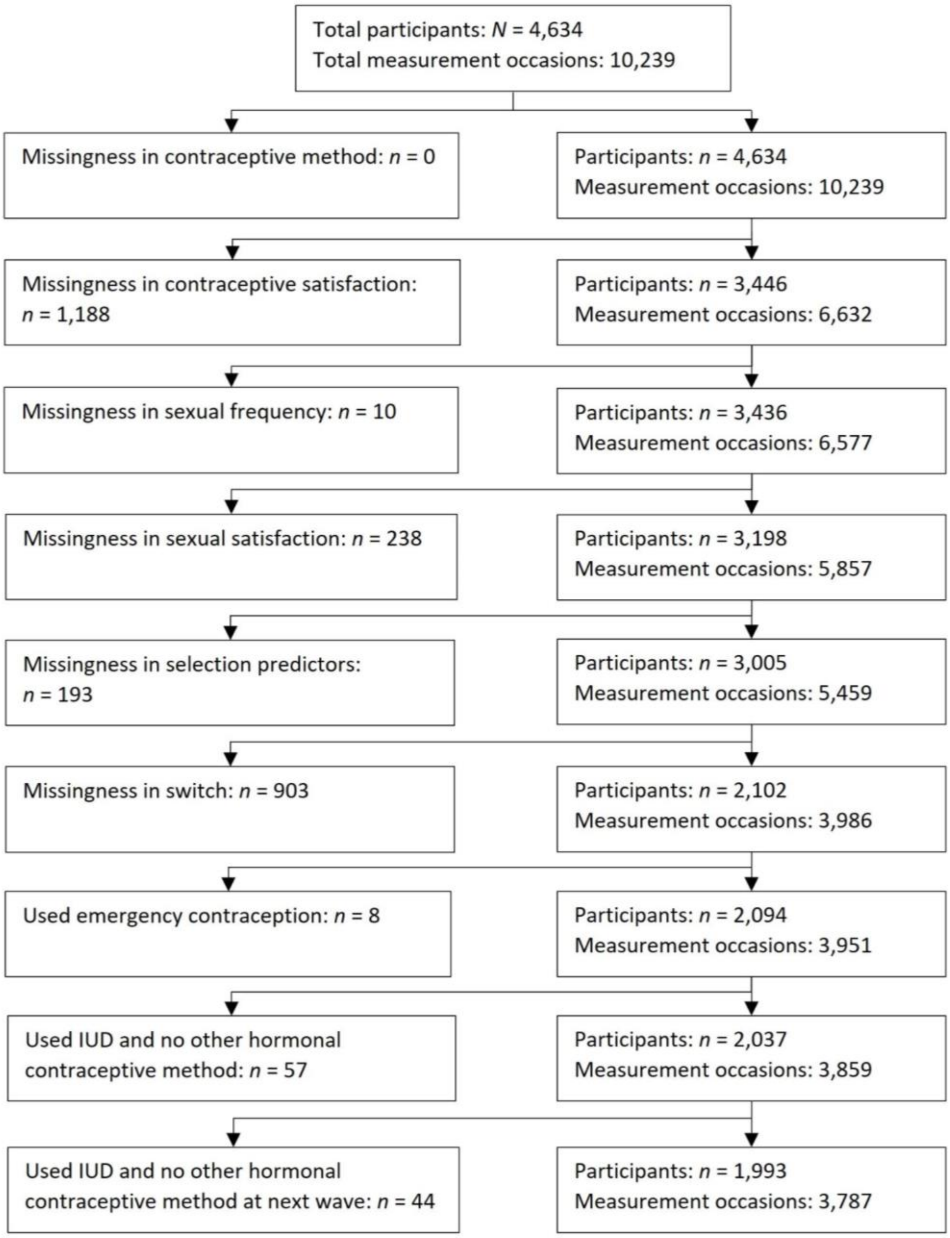
Exclusion Criteria

Figure 1 displays a flowchart and Table S7 in the supplemental material D provides an overview of the hierarchical exclusion criteria applied in the main analyses. It was possible that some women were excluded because of multiple exclusion criteria (e.g., because of missingness in contraceptive satisfaction and missingness in the switch).

The 4,634 eligible participants, who completed the initial survey at T_1, reported 10,239 measurement occasions. A total of 2,641 women and 6,452 measurement occasions were excluded for the main analyses, resulting in a sample size of 1,993 women and 3,787 measurement occasions for the main analyses. This sample size is comparable to or even larger than those in literature on hormonal contraceptive use (e.g., Malmborg et al., 2015; Rocca et al., 2013). Supplement E contains a comparison of the included and excluded samples.

Figure 1

Hierarchical Exclusion Process



Note. Flowchart shows the number of participants after each exclusion step, the number of participants that fulfilled each exclusion criteria could thus be higher as women could be excluded in an earlier step (e.g., used emergency contraception but were excluded because of missingness in switch). Missingness in contraceptive satisfaction was due to women who reported that they were not currently using any contraceptive method. For total *N* of participants that fulfilled the exclusion criteria see Table S7 in Supplement D.

Participants

Description of participants refers to the included sample at T_1, which consisted of n = 1,723[8] women of which nearly 60% were using hormonal contraceptives (for a detailed overview of all contraceptive methods and combined use of hormonal and non-hormonal contraceptives see Figure S4 in the supplemental material F). The average age of the participants was 28.15 years (*SD* = 5.18, range: 18–39 years). The majority (68%) of women were white and non-Hispanic, followed at a large distance by Hispanic women (16%). Most of the participants (35%) had a Bachelor's degree, followed by 25% that stated to have left college without a degree. The vast majority (63%) indicated working as a paid employee, whereas 33% indicated to be not working[9] and nearly 5% indicated working self-employed. They had an average poverty rating of 313.7 (*SD* = 232, range: 14-1,455) with a score of 100 relating to a poverty line based on a computation of the US Government, for the exact computation see https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines (US Government ASPE, 2022). Based on this categorization, 18% of all participants lived in poverty. Additionally, most participants (85%) were covered by health insurance. Most of the participants (75%) were in a serious relationship, with an average relationship duration of 7.61 years (*SD* = 4.90 years, range: 0-27 years[10]). Nearly 54% had no children, followed by 19% that indicated having one child and 18% with two children. Geographically, most participants (32%) came from the South of the USA, the fewest (16%) from the Northeast.

[8] Note that some women only participated at T_2 or T_3 due to exclusion criteria, so this explains the difference to the total sample of N = 1,993 for the main analyses.
[9] Note that this category included women that were not working because they were on a temporary lay-off from a job (n = 12), because they were looking for a job (n = 186), because they were disabled (n = 26) and because of other reasons (n = 340).
[10] Note that one woman indicated a relationship duration of 45.17 years. As the highest possible age was 39 years, this might have been a typing error. Nevertheless, we did not alter the value and the woman was not excluded from our analysis.

Variables and Indices

All variables were assessed through self-report measures. The full wording as well as answering scales for the variables analyzed in the main analyses can be found in Supplement G. Note that there are further measured variables in the CCCU by Jones (2018a) which were not incorporated in this study's analyses (see https://www.icpsr.umich.edu/web/ICPSR/studies/37067/variables).

Women were surveyed about their contraceptive method by answering two items, one displaying mostly hormonal methods and one displaying solely non-hormonal contraceptive methods. It was possible to choose more than one hormonal method or non-hormonal contraceptive method as well as a combination of both or no contraceptive method at all. Contraceptive use was recoded as a binary predictor based on women's chosen contraceptive method. If women reported using the birth control pill, the patch, the ring, the depot injection, or the implant, they were coded as hormonal contraceptive users, even if they reported further use of non-hormonal contraceptives. If women reported only using non-hormonal contraceptives such as condoms, vasectomy, withdrawal, natural family planning methods, spermicides, or if they reported not using any contraceptive method, they were classified as non-hormonal contraceptive users. If women reported using the IUD as their sole contraceptive method, they were classified as missing because IUD was referring to both, hormonal and non-hormonal IUD and it was thus impossible to categorize users of IUD.

The outcome of interest in the current study were switches between hormonal and non-hormonal methods. They were calculated by comparing the contraceptive method in one wave to the method in the subsequent wave. Any change in method whereby women switched from a hormonal to a non-hormonal method or vice versa was considered a switch.

Women were asked about their contraceptive satisfaction for each method that they reported. As women could choose more than one contraceptive method and thus indicate their contraceptive satisfaction for more than one method, the predictor contraceptive satisfaction was calculated by choosing the highest satisfaction value for all chosen contraceptive methods (within either hormonal or non-hormonal contraception[11]).

Sexual frequency was assessed by asking women if they had sexual intercourse with a male partner in the past 30 days and – if so – how many times they had sexual intercourse with a man in the past 30 days. Women could then report their sexual frequency categorically from one to eleven times or more (for exact response categories see Supplement G). If women reported that they did not have sexual intercourse or that they had sexual intercourse once in the last 30 days with a man, sexual frequency was coded to “no sex or once”, so that the two categories were combined. Otherwise, the categorical values from the item asking how many times women did have sex in the last 30 days were used. In addition, sexual satisfaction was incorporated as a continuous predictor.

To account for potential observed selection variables that might influence predictors or the outcome, the following measured selection variables were incorporated in the analyses: age, educational degree, poverty rating, health problems, medical problems, covered by insurance, gaps in their health insurance, number of kids, if women were pregnant or had a baby between waves, pregnancy avoidance, pregnancy feelings and relationship duration. For a comprehensive overview of all selection variables see Supplement G.

Analyses

For the code, the statistical software R version 4.2.2 (R Core Team, 2021) was used. For the statistical analyses we used the packages *brms* (Bürkner, 2017), *EValue* (version

[11] This means that if women were classified as hormonal contraceptive users, the highest contraceptive satisfaction value of the chosen hormonal contraceptives was used to create this variable. If women were classified as non-hormonal contraceptive users, the highest satisfaction value of the chosen non-hormonal contraceptives was used.

4.1.3; VanderWeele & Ding, 2011), *marginaleffects* (version 0.5.0; Arel-Bundock, 2022) and *sjPlot* (version 2.8.10; Lüdecke, 2021).

Main Analyses

Hypotheses were tested via Bayesian multilevel regression modeling with default priors for all parameters. Four consecutive binomial generalized linear mixed models were used, with the switch as the outcome and the predictors mentioned in the following. For the main analyses, the first "basic" model (H1) included the type of contraceptive method as a predictor for switching the method. The second model (H2 & H3) additionally included contraceptive satisfaction. The third model (H4-H9) additionally included sexual satisfaction and sexual frequency. The fourth and last model (H10-H15) additionally included all observed selection variables described above[12]. Each model included an interaction term of the predictors and observed selection variables with hormonal contraceptive use. Additionally, all models included a random intercept per participant. For all models, hormonal contraceptive users served as a reference group.

Sensitivity Analyses

Sensitivity analyses were performed to account for the impact of unobserved selection effects on the association between predictors and the outcome. Our aim was to determine the necessary magnitude of unobserved selection to nullify potential effects of the predictors on the outcomes. For sensitivity analyses, E-values from the *EValue* package (version 4.1.3; VanderWeele & Ding, 2011) were used, as they account for continuous and categorical unobserved confounders simultaneously.

[12] For the third and fourth model, we performed additional analyses estimating the effects of sexual satisfaction and sexual frequency on the probability to switch separately without controlling for contraceptive satisfaction.

E-values are calculated from risk ratios (or approximations such as odds ratios). For the detailed derivation and computation see VanderWeele et al. (2020). VanderWeele et al. (2020) recommend reporting the E-value for the estimated effect (how strong would unobserved confounders need to be to shift the estimated effect of the predictor on the outcome to zero) *and* for significance testing (how strong would unobserved confounders need to be to shift the confidence interval to include the null). Risk ratios and E-values were computed based on the statistical models using odds ratios with a 99.7% CI. A comparison of the potential unobserved confounding with and without the inclusion of observed selection variables was needed for inferences about how strong unobserved confounders would need to be in comparison to observed confounders. We therefore computed the E-Values once unconditional upon the observed selection variables (based on model 3, not including the observed selection variables) and once conditional upon the observed selection variables (based on model 4, which included all observed selection variables). Thus, we additionally report a descriptive difference in E-values for the association an unobserved confounder needs to have with predictor and outcome to explain away the predictor-outcome association, before and after confounding is partly explained by observed confounders.

Robustness Analyses

Two analyses of robustness were conducted to see robustness of effects when a subsample was excluded additionally to the exclusion criteria applied to the main and the sub analyses (for robustness analyses of sub analyses see Supplement B).

Analyses of Robustness 1. For the first analyses of robustness women were excluded in waves if they did not have sex in the last 30 days, so that data of 1,907 women (3,556 measurement occasions) were available.

Analyses of Robustness 2. For the second analyses of robustness women were excluded in waves if they indicated that they had undergone tubal ligation as contraceptive method or if their partner used vasectomy as contraceptive method. Following this, data of 1,984 women (3,750 measurement occasions) were available.

Inference Criteria

The smallest effect size of interest (SESOI) served as the primary inference criterion. In the CCCU, the overall probability to switch contraceptive methods was 11.9%. We therefore considered the SESOI as a change in the probability to switch of 1% for main effects. This way, the SESOI was nearly a tenth of the overall probability to switch. For the interaction effects, the SESOI was considered as a difference in the change in the probability to switch of 0.1% between hormonal and non-hormonal contraceptive users. This means that hormonal users needed to show an effect that was 0.1 times greater than the effect of the non-hormonal contraceptive users.

The confidence intervals for all effects were calculated at 99.7%. This significance threshold of .05 was adjusted due to multiple testing for the number of hypotheses (15 hypotheses overall for main analyses)[13]. Therefore, an effect was considered significant when the 99.7% CI excluded 0 within two-tailed statistical testing. Consequently, if an effect size and its 99.7% CI included 0, the hypothesis was rejected. Therefore, only hypotheses were accepted, if the effect size and its 99.7% CI excluded the defined SESOI. In addition to calculating unstandardized beta coefficients (*b*), we computed the probability to switch using average marginal effects (AMEs) from the package *marginaleffects* (version 0.5.0, Arel-

[13] Note that this adjustment might lead to rather conservative acceptance of hypotheses and for example Rubin (2021) claims that alpha adjustment is not automatically necessary when testing multiple hypotheses. However, as this study contained within-women testing and the number of participants was relatively high, we decided to adjust the confidence interval.

Bundock, 2022). AMEs measure the average change in the outcome when the predictor changes by one unit (Arel-Bundock, 2022).

Availability of Data, Code and Analyses

Original data from the CCCU (Jones, 2018a) can be downloaded via this link https://www.icpsr.umich.edu/web/DSDR/studies/37067/datadocumentation (Jones, 2018c). The code for this study is available in the following GitHub project: https://GitHub.com/chiaradraxler/hc_switch_cccu as well as in the following Open Science Framework project: https://osf.io/nqtup/.

Results

Descriptive Statistics

Descriptive statistics for predictors and observed selection variables at T_1, T_2, and T_3 are reported in Tables S9 to S11 in Supplement H in the supplemental material. Note again that from T_4 only the switch was used as a variable to predict a switch to T_4 with variables from T_3 (i.e., there was no T_5 for which variables from T_4 could predict a switch). For the report about the number of women that switched methods from T_3 to T_4 see Table S12, as the switch was incorporated in the description of T_3.

Table 1 shows zero-order correlations of all numerical predictors and observed selection variables at T_1. Zero-order correlations of all numerical variables for T_2 and T_3 are reported in Tables S12-S13 in Supplement H in the supplemental material. All significant correlations were in a range between $r = |.06|$ and $r = |.25|$ except for the large negative correlation between pregnancy avoidance and pregnancy feelings ($r = -.61$). All other correlations were not significant with $p > .05$. Comparing correlations to T_2 and T_3, results were nearly, though not completely, identical.

Table 1

Zero-Order Correlations with 95% Confidence Interval for Numerical Variables at T_1

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
(1) CSat						
(2) Dur	**.15** **[.09; .21]**					
(3) SSat	**.16** **[.11; .21]**	.01 [-.05; .07]				
(4) Age	.02 [-.03; .06]	**.25** **[.19; .31]**	-.03 [-.08; .02]			
(5) Poverty rating	**.06** **[.01; .10]**	**.15** **[.09; .21]**	-.01 [-.06; .04]	**.18** **[.14; .23]**		
(6) Pregnancy avoidance	**.13** **[.08; .17]**	.02 [-.04; .08]	-.03 [-.08; .02]	**-.14** **[-.18; -.09]**	-.02 [-.07; .03]	
(7) Pregnancy feelings	**-.06** **[-.11; -.02]**	-.03 [-.09; .03]	**.12** **[.08; .17]**	**.20** **[.16; .25]**	-.04 [-.08; .01]	**-.61** **[-.64; -.58**]

Note. The sample consisted of n = 1,723, except for contraceptive duration with n = 1,032 (because duration values were only available for hormonal contraceptive users). Bold correlations differed from zero with a 95% CI. CSat = contraceptive satisfaction, Dur = contraceptive duration, SSat = sexual satisfaction.

Main Analyses

Summary of Results

Table 2 displays results for the first, second, third, and fourth multilevel regression model. Supplement I in the supplemental material displays results for additional analyses estimating the effects of sexual satisfaction and sexual frequency on the probability to switch separately without controlling for contraceptive satisfaction. Supplement J in the supplemental material displays results for the first robustness analyses and Supplement K for the second robustness analyses. Figure 2 shows a forest plot of effects over all four models in main analyses. Figure S5 in Supplement L in the supplemental material displays a forest plot of effects over all four models in main analyses and robustness analyses. Figure 3 shows the probability to switch for contraceptive satisfaction, Figure 4 for sexual satisfaction, and Figure 5 for sexual frequency within (no)hormonal contraceptive users.

Table 2

Main Analyses Results for the First, Second, Third and Fourth Multilevel Regression Model

Predictor	**Multilevel regression model 1**		**Multilevel regression model 2**		**Multilevel regression model 3**		**Multilevel regression model 4**	
	H	***b*** **[CI]**	**H**	***b*** **[CI]**	**H**	***b*** **[CI]**	**H**	***b*** **[CI]**
Hormonal contraceptive use	H1	**-1.07 [-1.52; -0.67]**		**-2.08 [-3.56; -0.60]**		-1.33 [-3.30; 0.50]		-0.04 [-2.61; 2.42]
Contraceptive satisfaction			H2	**-0.61 [-0.89; -0.32]**	H4	**-0.65 [-0.93; -0.35]**	H10	**-0.72 [-1.08; -0.39]**
Interaction: Contraceptive satisfaction: Hormonal contraceptive use			H3	0.28 [-0.16; 0.72]	H5	0.38 [-0.11; 0.85]	H11	0.43 [-0.15; 1.01]
Sexual Satisfaction					H6	0.13 [-0.06; 0.32]	H12	0.07 [-0.14; 0.29]
Interaction: Sexual satisfaction: Hormonal contraceptive use					H7	-0.22 [-0.54; 0.11]	H13	-0.01 [-0.39; 0.39]

Table 2 (continued)

Main Analyses Results for the First, Second, Third and Fourth Multilevel Regression Model

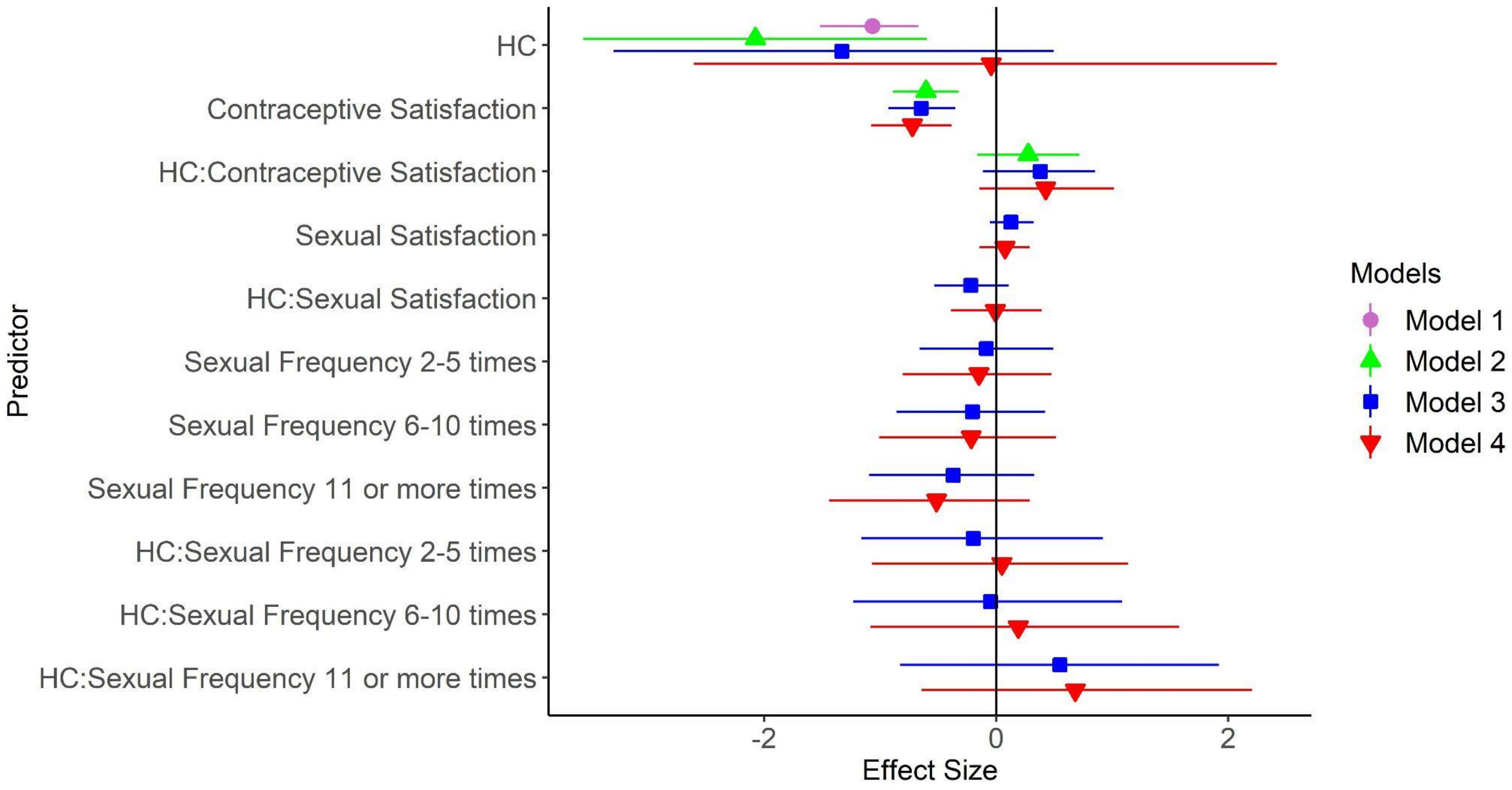
Predictor	**Multilevel regression model 1**		**Multilevel regression model 2**		**Multilevel regression model 3**		**Multilevel regression model 4**	
	H	***b*** **[CI]**	**H**	***b*** **[CI]**	**H**	***b*** **[CI]**	**H**	***b*** **[CI]**
Sexual frequency					H8		H14	
- 2-5 times						-0.09 [-0.66; 0.49]		-0.15 [-0.81; 0.48]
- 6-10 times						-0.21 [-0.86; 0.42]		-0.22 [-1.01; 0.51]
- 11 times +						-0.37 [-1.09; 0.33]		-0.51 [-1.44; 0.29]
Interaction: Sexual frequency: Hormonal contraceptive use					H9		H15	
- 2-5 times						-0.20 [-1.16; 0.92]		0.05 [-1.07; 1.14]
- 6-10 times						-0.05 [-1.23; 1.08]		0.19 [-1.08; 1.58]
- 11 times +						0.55 [-0.83; 1.92]		0.68 [-0.64; 2.21]

Note. For main analyses, the number of observations was 3,787 with *N* = 1,993 women. *H* = hypothesis according to predictor and model.

b = unstandardized beta coefficient. Bold results differed from zero with a 99.7% CI.

Figure 2

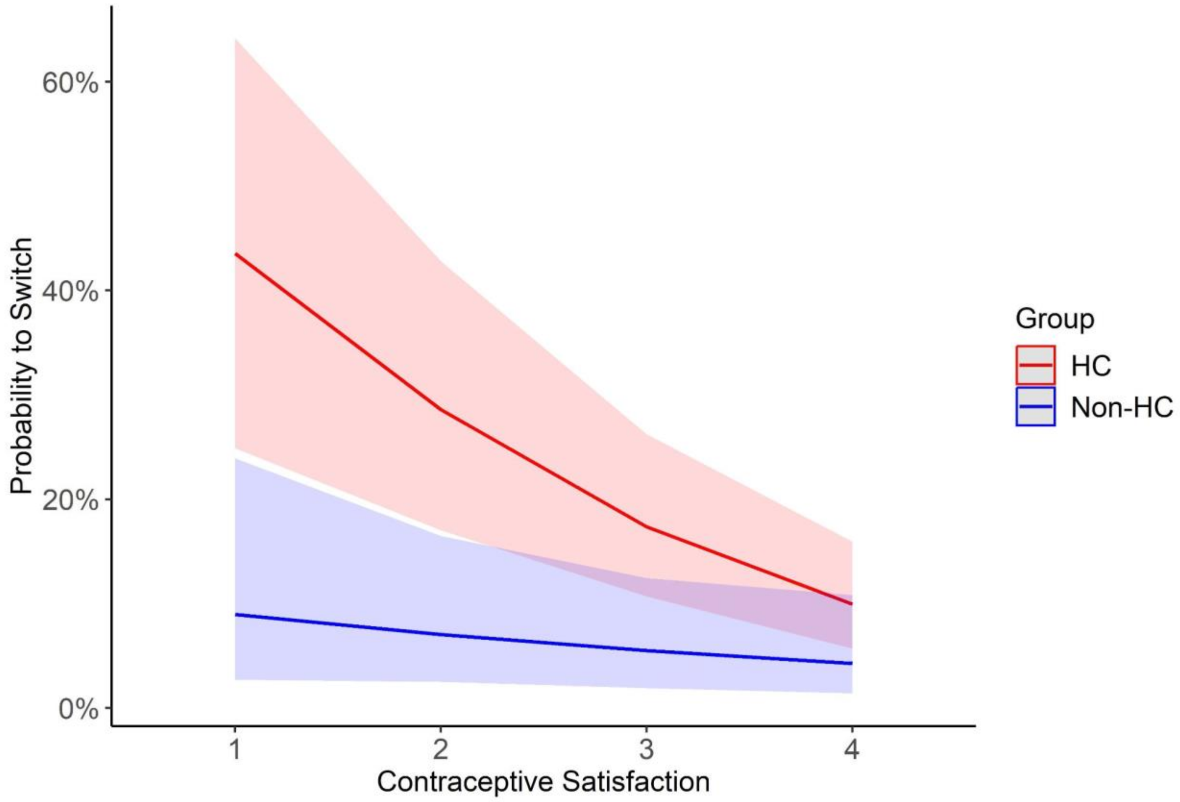
Effect Size Estimates for Model 1, 2, 3 & 4 in Multilevel Main Analyses



Note. N of observations and women can be found in section "Exclusion Criteria" for all multilevel analyses. HC = hormonal contraceptive use.

Figure 3

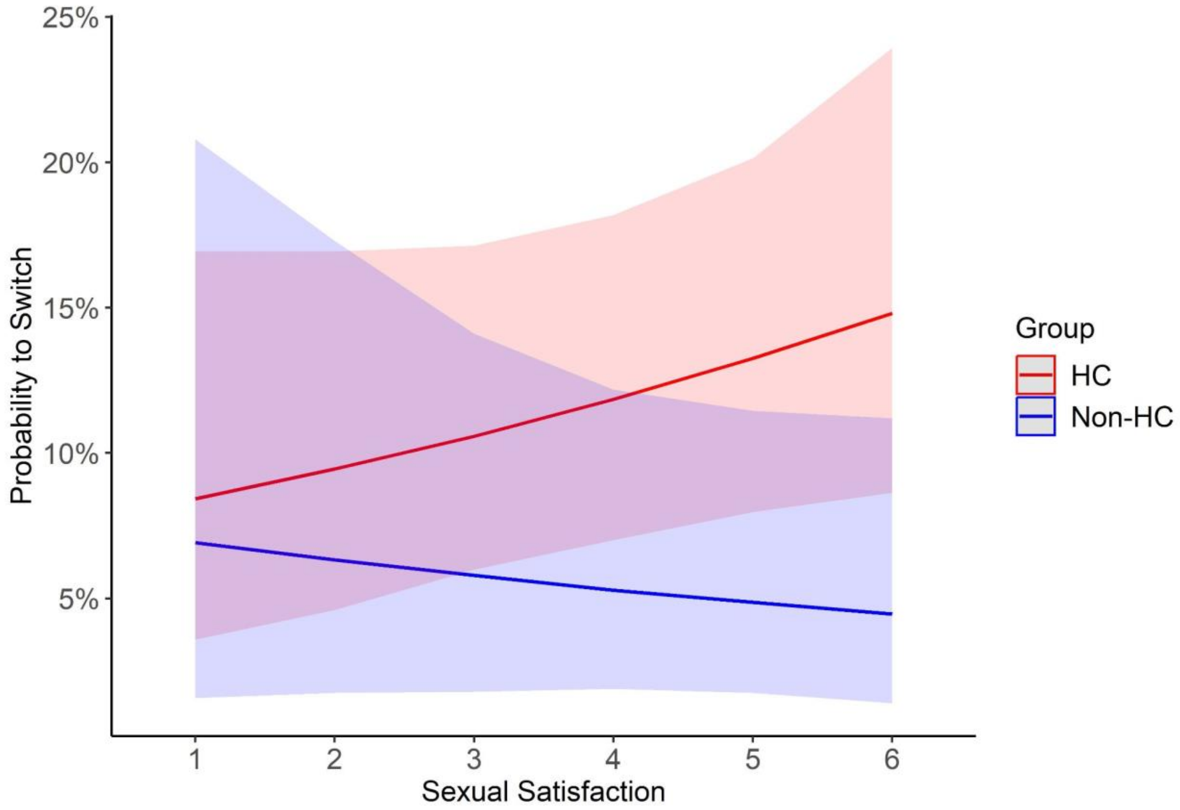
AMEs for Contraceptive Satisfaction Within Hormonal and Non-Hormonal Contraceptive Users Based on Multilevel Model 3



Note. For main analyses, the number of observations was 3,787 with *N* = 1,993 women. AME = average marginal effect. HC = hormonal contraceptive users. Non-HC = non-hormonal contraceptive users.

Figure 4

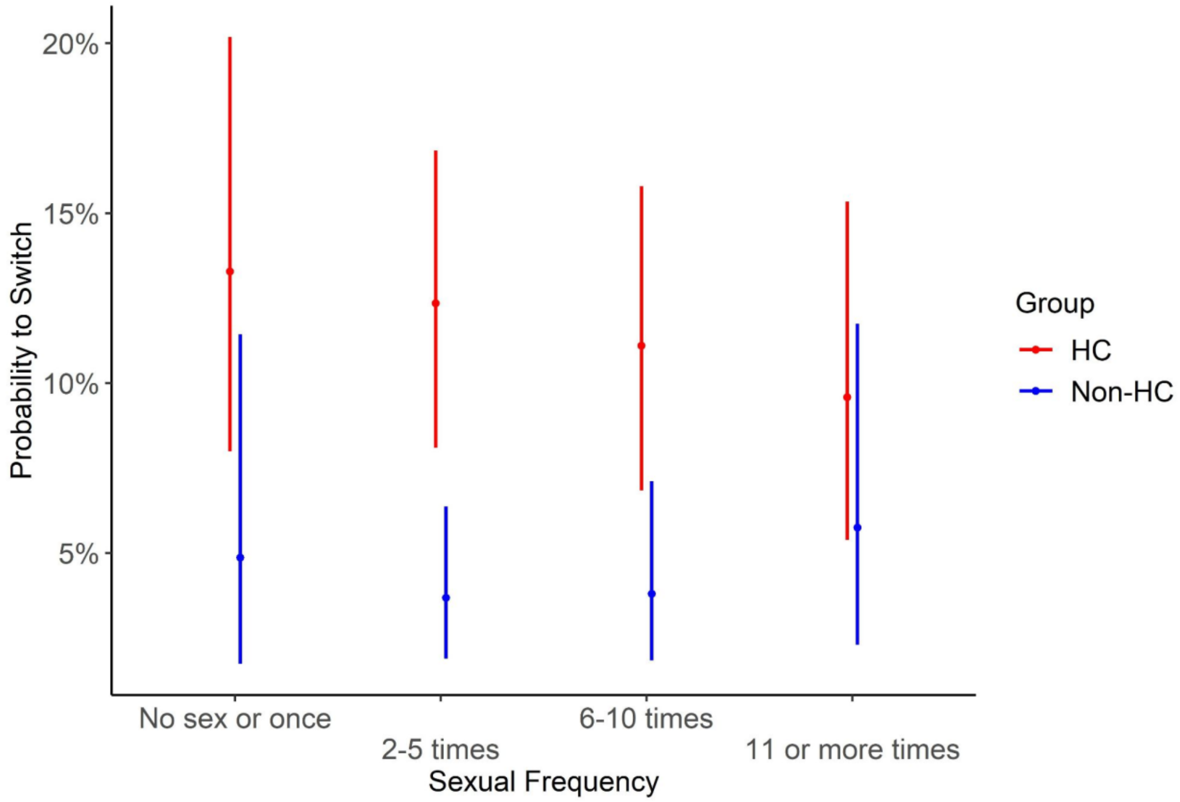
AMEs for Sexual Satisfaction Within Hormonal and Non-Hormonal Contraceptive Users Based on Multilevel Model 3



Note. For main analyses, the number of observations was 3,787 with *N* = 1,993 women. AME = average marginal effect. HC = hormonal contraceptive users. Non-HC = non-hormonal contraceptive users.

Figure 5

AMEs for Sexual Frequency Within Hormonal and Non-Hormonal Contraceptive Users Based on Multilevel Model 3



Note. For main analyses, the number of observations was 3,787 with *N* = 1,993 women. AME = average marginal effect. HC = hormonal contraceptive users. Non-HC = non-hormonal contraceptive users.

Effects for Method-Related Predictors, Sexual Satisfaction and Sexual Frequency

Effects from the first and second models were nearly, though not completely, identical to the third model, thus only AMEs from the third model after including all main predictors are reported below.

Over all three models, the method-related predictors hormonal contraceptive use and contraceptive satisfaction differed from zero with a 99.7% CI, except for hormonal contraceptive use in the third model with an effect size of b = -1.33 [-3.30; 0.50]. The interaction between contraceptive satisfaction and hormonal contraceptive use as well as the effects of sexual satisfaction and sexual frequency and their interaction with hormonal contraceptive use did not significantly predict the switch. These predictors were also non-significant in additional separate models without control for contraceptive satisfaction (see Supplement I).

Concerning substantiality, AMEs were taken into account when effect sizes differed significantly from zero. Over all three models, AMEs and their confidence interval for the method-related predictors hormonal contraceptive use and contraceptive satisfaction were greater than 0.01, leading to a predicted probability to switch greater than the SESOI. For the variable hormonal contraceptive use this corresponds to a 10% smaller probability to switch (AME = -0.10; [-0.13; -0.07]) for non-hormonal contraceptive users compared to hormonal users. The probability to switch decreased by 5% (AME = -0.05; [-0.07; -0.03]) when contraceptive satisfaction increased by 1 point. Considering the nonsignificant interaction between contraceptive satisfaction and hormonal contraceptive use, AMEs differed, however, substantially. The AME for contraceptive satisfaction within hormonal users was -0.08 [-0.11; -0.05], meaning that hormonal users had an 8% smaller probability to switch when their contraceptive satisfaction increased by 1 point. The AME for contraceptive satisfaction within non-hormonal contraceptive users was -0.01 [-0.04; 0.02], meaning that contraceptive satisfaction played no role in predicting the probability to switch for non-hormonal users. The substantial interaction effect can also be seen in Figure 3, nevertheless one has to be cautious interpreting the effect, as the regression coefficient for the interaction was *not* significant.

Effects of Observed Confounders

Including observed confounders in the fourth regression model did not change conclusions about significance and substantiality for effects of hormonal contraception, contraceptive satisfaction, and their interaction based on regression coefficients and AMEs.

The probability to switch decreased by 2% when pregnancy avoidance[14] increased by 1 point (AME = -0.02; [-0.03; -0.004]). Considering the interaction between pregnancy avoidance and hormonal contraceptive use[15], hormonal users had a 3% smaller probability to switch when their pregnancy avoidance increased by 1 point (AME = -0.03; [-0.05; -0.02]) and pregnancy avoidance played no role in predicting the probability to switch for non-hormonal contraceptive users (AME = 0.01; [-0.005; 0.03]). Considering the interaction between pregnancy feelings and hormonal contraceptive use[16], an increase by 1 led to a 2% higher probability to switch for hormonal users (AME = 0.02; [0.002; 0.04]) but to a 2% lower probability to switch for non-hormonal contraceptive users (AME = -0.02; [-0.03; -0.0002]). Considering the interaction between age and hormonal contraceptive use[17], age played no role in predicting the probability to switch for hormonal users (AME = 0.002; [-0.005; 0.01]), but an increase by 1 led to a 1% smaller probability to switch for non-hormonal contraceptive users (AME = -0.01; [-0.01; -0.002]). All other predictors and observed selection variables did not differ from zero with a 99.7% CI.

Sensitivity to Unobserved Confounders

To see effects' sensitivity to unobserved confounders unconditional and conditional on observed confounders, E-values for the effect of contraceptive satisfaction, which was the

[14] Pregnancy avoidance showed an effect size of *b* = -0.39 [-0.60; -0.19].
[15] The interaction between pregnancy avoidance and hormonal contraceptive use showed an effect size of *b* = 0.63 [0.29; 1.03].
[16] The interaction between pregnancy feelings and hormonal contraceptive use showed an effect size of *b* = -0.53 [-0.89; -0.19].
[17] The interaction between age and hormonal contraceptive use showed an effect size of *b* = -0.15 [-0.26; -0.05].

only robust effect across models, were computed for the third (i.e., not including observed confounders) and the fourth multilevel regression model (i.e., including observable confounders).

Contraceptive Satisfaction. The observed risk ratio association for the effect of contraceptive satisfaction on the probability to switch before including all observed selection variables was 0.72 [0.63; 0.84][18]. The E-value for the point estimate was 2.11. Thus, with an observed risk ratio of 0.72, an unmeasured confounder that was associated with both, contraceptive satisfaction and the switch by risk ratios of 2.11-fold each, would suffice to explain away the effect of contraceptive satisfaction on switch but weaker confounding would not (wording according to Aloisi et al., 2022; VanderWeele et al., 2020).

The E-value for significance testing of the point estimate was 1.67, thus an unmeasured confounder that was associated with both, contraceptive satisfaction and the switch by risk ratios of 1.67-fold each, would suffice to reach the conclusion that the effect of hormonal contraceptive use on probability to switch was not significant anymore. More precisely, if the actual associations between the unobserved confounder with contraceptive satisfaction and the switch are less than 1.67, then the effect of contraceptive satisfaction on the probability to switch adjusted by the unmeasured confounder will be in the same direction as the observed effect of contraceptive satisfaction on the switch (wording according to VanderWeele et al., 2020).

The observed risk ratio association for the effect of contraceptive satisfaction on the switch *after* including all observed selection variables was 0.70 [0.58; 0.82]. Considering the E-Value of 1.72 for significance testing of the point estimate [2.23 for the point estimate itself], an association of the unmeasured confounders with both, contraceptive satisfaction

[18] A risk ratio of 0.72 means that there is an inverse association, i.e., there is a decreased risk for switching contraceptive methods when contraceptive satisfaction increases. For an increase by one in contraceptive satisfaction, a woman has 0.72 times the risk of switching their contraceptive method compared to no increase by one in contraceptive satisfaction.

and the switch by risk ratios of 1.72-fold each, *conditional* on all 13 observed covariates, would suffice to reach the conclusion that the effect of contraceptive satisfaction on the switch adjusted by the unmeasured confounder was not significant anymore.

A difference of |0.05| for significance testing of the point estimate (|0.12| in the E-values for the point estimate) before and after including observed selection variables was observed, meaning that controlling for observed selection variables did not reduce the effect of contraceptive satisfaction on the probability to switch. The observed E-values led to the interpretation that only small-sized confounding is necessary to reach the conclusion that the effect of contraceptive satisfaction is not significant, even after controlling for observed selection variables (for interpretation of different E-values see Linden et al., 2020).

Robustness Analyses for Main Analyses

Considering the first and second model, the effects of hormonal contraceptive use and contraceptive satisfaction differing from zero with a 99.7% CI were robust in robustness analyses 1 and 2. With regard to the third model, results with only contraceptive satisfaction differing from zero with a 99.7% CI remained unchanged, except for sexual satisfaction differing from zero with a 99.7% CI in the first robustness analysis[19]. Nevertheless, the average marginal effect for sexual satisfaction in the second robustness analysis did not differ from zero with a 99.7% CI. Here, the probability to switch increased by 1% (AME = 0.005; [-0.01; 0.02]) when sexual satisfaction increased by 1 point.

For the fourth model, the first and second robustness analyses yielded the same effects that differed from zero with a 99.7% CI, similar to the main analyses model, except that the variable pregnancy feelings now differed from zero with a 99.7% CI and an AME of 0.005 [-0.01; 0.02] in the second robustness analysis.

[19] Sexual satisfaction showed an effect size of b = 0.22 [0.01; 0.45].

Discussion

This study aimed to model predictors of contraceptive switches in a longitudinal sample and found evidence for substantial effects of type of contraceptive method and contraceptive satisfaction. However, evidence for the interaction between type of contraceptive method and contraceptive satisfaction remains questionable. The effect of contraceptive method was explained by including sexuality-related variables. The inclusion of observed selection variables did not change the effect of contraceptive satisfaction. We found no evidence for direct effects of sexual satisfaction and sexual frequency in main analyses (with and without control for contraceptive satisfaction, see Supplement I), and neither for contraceptive duration in sub analyses (Supplement B). For a detailed evaluation of hypotheses, significant and substantial effects and robustness of effects see Table 3.

Descriptive differences indicate that controlling for observed selection variables did not reduce the effect of contraceptive satisfaction on the probability to switch. The observed E-values suggest that only minor confounding is required to conclude that the effect of contraceptive satisfaction is insignificant, after controlling for observed selection variables. Nearly all observed effects remained robust when excluding a potentially distorting subsample of the total sample in robustness analyses.

Table 3

Overview of Significance, Substantiality, Robustness of Results and Evaluation of Hypotheses

H	Predictor	Significant Effect?	Substantial Effect?	Robustness of Results? R1	Robustness of Results? R2	Hypotheses Evaluation
H1	HC	✓[a]	✓[a]	✓	✓	Accepted
H2	CS	✓	✓	✓	✓	Accepted
H3	HC: CSat	X	✓	✓	✓	Accepted
H4	CSat	✓	✓	✓	✓	Accepted
H5	HC: CSat	X	✓	✓	✓	Accepted
H6	SSat	X	X	X	✓	Rejected
H7	HC: SSat	X	X	✓	✓	Rejected
H8	SFreq	X	X	✓	✓	Rejected
H9	HC: SFreq	X	X	✓	✓	Rejected
H10	CSat	✓	✓	✓	✓	Accepted
H11	HC: CSat	X	✓	✓	✓	Accepted
H12	SSat	X	X	✓	✓	Rejected
H13	HC: SSat	X	X	✓	✓	Rejected
H14	SFreq	X	X	✓	✓	Rejected
H15	HC: SFreq	X	X	✓	✓	Rejected

Note. N of observations and women can be found in section “Exclusion Criteria” for all multilevel analyses. H = hypothesis; R = robustness analyses; HC = hormonal contraceptives; CSat = contraceptive satisfaction; SSat = sexual satisfaction; SFreq = sexual frequency; [a] = except for the third model; ✓ = yes; X = no

Type of Contraceptive Method

This study found significant and substantial effects of hormonal contraceptive use on the probability to switch, with a 9% - 10% higher probability to switch methods for hormonal contraceptive users relative to non-hormonal contraceptive users. This result corresponds with previous literature that has found high discontinuation rates of 28% - 80% for hormonal contraceptive users (e.g., Hooper, 2010; Moreau et al., 2009). A higher probability to switch for hormonal contraceptive users is consistent with the idea that method-related side effects of hormonal contraceptives result in a higher probability to switch for hormonal contraceptive users (e.g., Hall et al., 2014; Le Guen et al., 2021; Simmons et al., 2019).

The Importance of Contraceptive Satisfaction

This study found significant and substantial main effects for contraceptive satisfaction, alongside notable effects for hormonal contraceptive use. An increase by one unit in contraceptive satisfaction was linked with a by 5% decreased probability to switch over all models. Main effects of contraceptive satisfaction remained robust in the two analyses. Results correspond to the majority of literature, which suggest that higher contraceptive satisfaction is associated with continuous contraceptive use (e.g., Frost et al., 2007; Moreau et al., 2007; Peipert et al., 2011). Frost et al. (2007) already suggested that contraceptive satisfaction was one of the most important measures in predicting discontinuation (i.e., dissatisfied women change their contraceptive method). Corresponding to this, this study's models demonstrate that contraceptive satisfaction is the most critical predictor due to extensive proof of its impact on switching probability.

This argumentation is especially important because neither sexual frequency nor sexual satisfaction reached substantiality in the main analyses according to the SESOI (independently of the inclusion of contraceptive satisfaction as a predictor). The current study’s results suggest contraceptive satisfaction to be the only substantial predictor among the measured variables for contraceptive switches.

In addition to main effects for contraceptive satisfaction the literature also indicates that contraceptive satisfaction interacts with hormonal contraceptive use, as high rates of discontinuation due to dissatisfaction were found among hormonal contraceptive users (e.g., Moreau et al., 2007; Oddens, 1999; Peipert et al., 2011). Results of the current study align overwhelmingly with existing literature as the interaction term of contraceptive satisfaction and hormonal contraceptive use was found to be substantial, with a 7% - 8% smaller probability to switch for hormonal contraceptive users when their contraceptive satisfaction increased by 1 point compared to non-hormonal contraceptive users. Despite substantial AMEs, one has to be cautious interpreting the interaction term, as the interaction did not differ from zero with a 99.7% CI in all models.

Previous research suggested, (hormonal) side effects may be responsible for discontinuation because of dissatisfaction (Fathizadeh et al., 2011; Littlejohn, 2012; Peipert et al., 2011; Villavicencio & Allen, 2016). As these factors were not examined in the present study's research question, future studies ought to explore the impact of side effects on the satisfaction rate of contraceptive users.

Is the Importance of Contraceptive Satisfaction Plausible?

The conclusion that contraceptive satisfaction is a crucial predictor of contraceptive switches is not only comprehensible, but also plausible. Initially, one can conceptualize contraceptive users as consumers of a particular contraceptive commodity (Weisberg et al., 2013). Therefore, examining market models and consumption behaviors can also elucidate contraceptive consumption behavior. Moreover, the literature indicates that satisfaction significantly impacts consumption intentions.

With regard to health behavior, Kui-Son et al. (2004) discovered that patient’s satisfaction was positively linked to behavioral intentions, including recommending willingness, purchasing intentions and intentions of positive feedback. Similar results were obtained by Woodside et al. (1989). From a market-based perspective, Kalia et al. (2016) discovered that online consumer satisfaction positively correlates with future purchase intentions. The study further noted that this satisfaction mediates the influence of perceived service quality on future purchase intentions.

Kui-Son and colleagues (2004) argue that cognition impacts satisfaction, thereby determining the behavioral intention. Additionally, Martin et al. (2008) and Kalia et al. (2016) contend that satisfaction results from the difference between a consumer's expected outcome and the actual product, aligning with Kui-Son et al.'s (2004) cognitive perspective. This emphasizes the importance of understanding the influence of consumer expectations on satisfaction and the subsequent behavioral intentions. It is plausible that satisfaction impacts behavioral intention, thus affecting actual behavior, with dissatisfied users feeling the need to adjust (i.e., switch) their consumption.

This argument aligns with the theory of planned behavior (Fishbein & Ajzen, 1975), which has been successfully used in predicting both health behaviors (Fekadu & Kraft, 2002) and contraceptive behavior (Fazekas et al., 2001). Regarding continuous use of contraceptives, the attitude towards this behavior may depend on the satisfaction with the chosen method. Without the influence of external factors, a woman who experiences side effects and is dissatisfied with hormonal contraceptives may develop the perception that continued use is not beneficial. As a result, she may have no intention to continue using hormonal contraceptives, and in reality, discontinues its usage. However, note that Fishbein and Ajzen (1975) discuss the scarce evidence for the association of attitudes with intentions and behavior.

What can we Learn for Causal Inference?

This study provided initial evidence based on longitudinal data for causal effects of contraceptive satisfaction, hormonal contraceptive use, and its interaction with contraceptive satisfaction on the probability to switch and thus discontinuous contraceptive behavior.

The Causal Network

This study did not find any effects for the predictors of sexual satisfaction or sexual frequency on probability to switch, independently of whether we controlled for contraceptive satisfaction or not. This contradicts previous research indicating their importance for continuous contraceptive use (Higgins & Smith, 2016; Higgins et al., 2022) and identifying them to as predictors for continuous contraceptive use (e.g., Ersek et al., 2010; Frost et al., 2007; Kerns et al., 2003; Malmborg et al., 2015; Westhoff et al., 2007).

Finding no effects for sexual frequency and satisfaction could provide additional insight into literature criticizing the correlational cross-sectional study designs and discussing that finding no or positive effects of hormonal contraceptives on measures of sexuality might be due to contraceptive discontinuation because of hormonal side effects (e.g., Botzet et al., 2021; denoted as “attrition effects”). In short, the hypothesis is that women who experience negative effects (e.g., lower sexual frequency and satisfaction due to hormonal side effects), might switch from hormonal to non-hormonal contraceptives, covering negative and resulting in positive effects of hormonal contraceptives on sexuality in correlational cross-sectional designs. The hypothesis of switches in contraceptive methods because of reduced sexual frequency or sexual satisfaction could not be confirmed in the current study (even in models estimating their direct effects without control for contraceptive satisfaction), providing evidence that causal effects based on cross-sectional studies are not likely to be distorted by switches in contraceptive methods because of hormonal side effects.

Furthermore, pregnancy-related variables (i.e., pregnancy avoidance and pregnancy feelings) appear to influence switching behavior between contraceptive methods. Focusing on pregnancy avoidance, Jones (2017) analyzed the initial two waves of the here used CCCU sample and discovered that higher pregnancy avoidance was associated with more than two times higher odds of consistent contraceptive use. Likewise, Frost et al. (2007) discovered ambivalence about pregnancy avoidance to be associated with discontinuous contraceptive use in a nationally representative sample. Therefore, contrary to variables related to sexuality, the present study strongly indicates that the inclusion of pregnancy prevention in the causal network is essential for drawing conclusions about contraceptive discontinuation.

Constraints on Causal Inference

Further Unobserved Confounders. The extent to which this study included an exhaustive list of predictors and observed selection variables remains unclear. Table 1 in VanderWeele et al. (2020) provides a list of numerous covariates that were not included in the current study due to the pre-existing nature of the data, such as, among others, Big Five personality or political affiliation.

Especially for the Big Five it seems plausible that personality traits such as openness or extraversion may influence women to initially choose hormonal contraceptives (i.e., because they do not fear potential side effects). However, it may later lead women to switch contraceptives (i.e., because they frequently engage in the discussion about hormonal contraceptives). Results of Botzet et al. (2021) support this argumentation for the Big Five. They discovered that openness was negatively associated with current hormonal contraceptive use whereas conscientiousness was positively associated with it. In the same way, liberalism or the social network – which was shown to influence contraceptive use (Bornstein et al., 2021) – might function as confounders for the here found effects on contraceptive switches.

Furthermore, although this study incorporated selection variables related to sudden medical problems or health problems, it is crucial to include more extensive information about for example medication into the selection variables. The same applies to obtaining more comprehensive information regarding an individuals’ health status. For instance, decisions or recommendations from healthcare providers regarding the selection or change of contraceptives may rely on an individual's medical history, including factors such as high blood pressure and arterial thrombosis (Brito et al., 2011).

Following the suggestions of Rohrer (2019) and Rohrer and Lucas (2020) for causal inferences in longitudinal analyses, this study provides a list of observed confounders that were used in analyses. However, the list of observed confounders is not exhaustive. Future studies may benefit from investigating the association between the proposed variables and patterns of contraceptive use, as well as incorporating additional selection variables in the analysis to further elucidate the role of confounders in contraceptive switches and, subsequently, the causal structure of effects.

Systematic Missingness. This present study aimed to investigate the impact of excluding potentially distorting sub-samples in two robustness analyses on the observed effects. Analyses showed that results were overwhelmingly robust. There were two relevant sources of systematic missingness that we could not investigate further. First off, contraceptive switches of women who did not have sexual intercourse could not be incorporated in our analyses. And second, women who used no contraceptive method in the current or in the last wave and thus did not switch between hormonal and non-hormonal contraceptive methods could not be incorporated in our analyses due to missingness in contraceptive satisfaction. Based on the current study we cannot infer anything about women who stop using a contraceptive method but do not start using another method and women who start using a contraceptive method but used no contraceptive method before. Future research would thus profit from including women that did not have sex or used no contraceptive method. This is particularly important when the aim is to investigate the broader category contraceptive discontinuation instead of focusing solely on contraceptive switches.

What can we Learn to Support Women's Experiences with Contraceptive Methods?

Investigating how to promote uninterrupted contraceptive use is crucial not only to prevent unwanted pregnancies but also to improve women's experiences with contraceptive methods. Based on the results of the current study, we recommend to prioritize contraceptive satisfaction to address contraceptive switches, especially among hormonal contraceptive users. This is particularly important, because sexual satisfaction and sexual frequency were non-significant predictors of switching behavior and could not explain the effect of contraceptive satisfaction on contraceptive switches.

In order to improve contraceptive satisfaction (and thus contraceptive continuation), the primary objective for future research is to understand the reasons for contraceptive dissatisfaction. Women regularly discuss side effects of (hormonal) contraception (e.g., heavy flow, increased hunger, mood swings; see Le Guen et al., 2021). These side effects may contribute to contraceptive dissatisfaction and should be a focus of future research on reasons for contraceptive satisfaction. To promote contraceptive satisfaction and contraceptive continuation in women's daily lives, these findings could then be used to design a contraceptive method that has fewer of the relevant side effects that lead to contraceptive dissatisfaction and thereby contraceptive discontinuation.

However, another way to improve contraceptive continuation might be to help each woman to find her "perfect" contraceptive method, for example through contraceptive counseling that is tailored to women's individual needs. Here, transparency and consideration of women's perspectives seem to play a crucial role in supporting continuous contraceptive use (Merki-Feld et al., 2018). As one possible approach, Moreau et al. (2007) recommend counseling that focuses on the patient and her contraceptive expectations in order to identify the most appropriate method and increase contraceptive satisfaction. However, Moreau et al. (2007) also report that research on counseling is scarce, and according to a review by Halpern et al. (2013), only three out of nine trials showed benefits of counseling for contraceptive continuation. Therefore, the efficacy of counseling in order to improve the contraceptive fit – and thus contraceptive satisfaction and continuation – remains uncertain.

Strengths of the Current Study

Various contraceptive methods were included in the broader categories of hormonal and non-hormonal contraceptives, expanding the range of methods examined for switching behavior compared to the commonly criticized single method. This contributes to filling a gap in the literature (Higgins et al., 2008; Inoue et al., 2015; Littlejohn, 2012). Additionally, this study's sample size, despite the complex exclusion process, was comparable to or larger than samples in previous studies on hormonal contraceptive use (e.g., Malmborg et al., 2015; Rocca et al., 2013).

Additionally, this study had several key strengths that support causal inference and warrant further emphasis. Compared to previous cross-sectional studies, this longitudinal study specifically addressed contraceptive switches in modeling predictors of switching behavior over a two-year period. Furthermore, this study included observed selection variables and estimated effects' sensitivity to unobserved selection variables as well as robustness of effects when excluding specific sub samples. To summarize, this study's longitudinal design and thorough analyses strengthened causal inferences about predictors of contraceptive switches. As a result, the study was able to somewhat differentiate between the causal effects of predictors and the effects of confounders.

Limitations and Avenues for Future Research

Despite the strengths that this study has, its limitations should also be mentioned and discussed with regard to future research. In addition to the already mentioned limitations regarding unobserved confounders and systematic missingness, there are limitations to the generalizability of results since the sample for the CCCU study was derived solely from the US. It is possible that other predictors may be more relevant in different populations. In the samples' acquisition process, there was furthermore a high non-response rate (only 41% responded to the study's invitation) and a high drop-out over the four waves (only 40% of T_1 took part in T_4), meaning that generalizability is again more limited stemming from a potentially selective sample. With regard to the distribution of hormonal and non-hormonal contraceptive users it might even be possible that hormonal users were more likely to take part in the CCCU (e.g., because they thought to have a more effective contraceptive method). Results can thus only be cautiously generalized (for differences between this study's sample and the population in the USA see Bishaw & Fontenot, 2014; Finegold, 2013; US Department of Labor, 2013).

Following this, one research question for future investigation is whether there are differences in modeling discontinuation in hormonal contraceptive use between a broader sample of the United States and a sample outside the WEIRD population (Henrich et al., 2010). Future research could consider using the *National Family Health Survey 2015-2016* in India (International Institute for Population Sciences, 2017). For different populations, other predictors and selection variables may vary in importance.

Coming to another limitation, the CCCU was conducted from 2012-2014. As results of Lindh et al. (2016) suggested, contraceptive use patterns and reasons for discontinuation may change over time to some extent. Increased usage of social media in the current decade (Auxier & Anderson, 2021) could lead to a broader discussion about contraceptive methods. Such discourse could result in more controversial attitudes towards hormonal contraceptives. Consequently, this study solely portrays contraceptive switches between the years 2012 to 2014. Future research should shed light on how switches or discontinuation of hormonal contraceptives can be explained in the 2020s. Future research using a more recent sample should examine whether the here found effects can still be found in a more recent sample from the 2020s. Future research should analyze whether the effects discovered here still hold with a more current sample from the 2020s. Given the six-month inter-wave interval in this study, researchers could potentially increase the number of waves or decrease the inter-wave interval for improved modeling of switches.

Finally, future studies should investigate methods to enhance contraceptive satisfaction and promote continuous use, translating theoretical results into practical applications. Such research may facilitate self-directed, satisfied, and sustained contraceptive selection.

Conclusion

We studied contraceptive switches in a longitudinal design. Women who were less satisfied with their contraceptive method were more likely to switch their contraceptive method. Women who used hormonal contraception were more likely to switch on average, but this difference could in part be accounted for by differences in satisfaction and observed confounders. Sexual frequency and sexual satisfaction did not predict switching behavior. Future research should study further confounders, contemporary data, non-WEIRD samples, and try to reduce systematic missingness. A better understanding of why women switch or discontinue their contraceptives could help reduce unplanned pregnancies and abortions.

Acknowledgements

We thank Rachel D. Jones for making *The Continuity and Change in Contraceptive Use Study* dataset available for access by the general public.

Declaration of Interest

The authors have no relevant financial or non-financial interests to disclose.

Data Availability Statement

Original data from the CCCU (Jones, 2018a) can be downloaded via this link https://www.icpsr.umich.edu/web/DSDR/studies/37067/datadocumentation (Jones, 2018c).

Authors' Contributions

Conceptualization: Chiara N. Draxler & Laura J. Botzet; Conceptualization - Critical revision: Ruben C. Arslan & Lars Penke; Formal Analysis: Chiara N. Draxler & Laura J. Botzet; Investigation: Chiara N. Draxler; Methodology: Chiara N. Draxler & Laura J. Botzet; Project administration: Laura J. Botzet; Supervision: Laura J. Botzet; Validation: Ruben C. Arslan; Visualization: Chiara N. Draxler; Writing – original draft: Chiara N. Draxler & Laura J. Botzet; Writing – review & editing: Ruben C. Arslan & Lars Penke; Approval of final manuscript: Chiara N. Draxler, Ruben C. Arslan, Lars Penke, & Laura J. Botzet

References

Ali, M. M., & Cleland, J. (2010). Contraceptive switching after method-related discontinuation: Levels and differentials. *Studies in Family Planning*, *41*(2), 129–133. https://doi.org/10.1111/J.1728-4465.2010.00234.X

Aloisi, V., Gatto, A., Accarino, G., Donato, F., & Aloisio, G. (2022). The effect of known and unknown confounders on the relationship between air pollution and Covid-19 mortality in Italy: A sensitivity analysis of an ecological study based on the E-value. *Environmental Research*, *207*, 112131. https://doi.org/10.1016/j.envres.2021.112131

Arel-Bundock, V. (2022). *marginaleffects: Marginal effects, marginal means, predictions and contrasts*. R package version 0.5.0. https://vincentarelbundock.GitHub.io/marginaleffects/

Auxier, B., & Anderson, M. (2021). *Social media use in 2021*. Pew Research Center. https://www.pewresearch.org/internet/2021/04/07/social-media-use-in-2021/

Baird, D. T., & Glasier, A. F. (1993). Hormonal contraception. *The New England Journal of Medicine*, *328*(21), 1543–1549. https://doi.org/10.1056/NEJM199305273282108

Barden-O'Fallon, J., & Speizer, I. (2011). What differentiates method stoppers from switchers? Contraceptive discontinuation and switching among Honduran women. *International Perspectives on Sexual and Reproductive Health*, *37*(1), 16–23. https://doi.org/10.1363/3701611

Belete, N., Zemene, A., Hagos, H., & Yekoye, A. (2018). Prevalence and factors associated with modern contraceptive discontinuation among reproductive age group women, a community based cross-sectional study in Humera town, northern Ethiopia. *BMC Women's Health*, *18*(190), 1–8. https://doi.org/10.1186/s12905-018-0663-4

Bishaw, A., & Fontenot, K. (2014). *Poverty: 2012 and 2013 - American community survey briefs*. U.S. Census Bureau: Suitland, MD. https://www.census.gov/library/publications/2014/acs/acsbr13-01.html

Bitzer, J., & Simon, J. A. (2011). Current issues and available options in combined hormonal contraception. *Contraception*, *84*(4), 342–356. https://doi.org/10.1016/j.contraception.2011.02.013

Blanc, A. K., Tsui, A. O., Croft, T. N., & Trevitt, J. L. (2009). Patterns and trends in adolescents' contraceptive use and discontinuation in developing countries and comparisons with adult women. *International Perspectives on Sexual and Reproductive Health*, *35*(2), 63–71. https://doi.org/10.1363/3506309

Bornstein, M., Huber-Krum, S., Kaloga, M., & Norris, A. (2021). Messages around contraceptive use and implications in rural Malawi. *Culture, Health & Sexuality*, *23*(8), 1126–1141. https://doi.org/10.1080/13691058.2020.1764625

Both, S., Lew-Starowicz, M., Luria, M., Sartorius, G., Maseroli, E., Tripodi, F., Lowenstein, L., Nappi, R. E., Corona, G., Reisman, Y., & Vignozzi, L. (2019). Hormonal contraception and female sexuality: Position statements from the European Society of Sexual Medicine (ESSM). *Journal of Sexual Medicine*, *16*(11), 1681–1695. https://doi.org/10.1016/j.jsxm.2019.08.005

Botzet, L. J., Gerlach, T. M., Driebe, J. C., Penke, L., & Arslan, R. C. (2021). Hormonal contraception and sexuality: Causal effects, unobserved selection, or reverse causality? *Collabra: Psychology*, *7*(1), 29039. https://doi.org/10.1525/collabra.29039

Brito, M. B., Nobre, F., & Vieira, C. S. (2011). Hormonal contraception and cardiovascular system. *Arquivos Brasileiros de Cardiologia*, *96*(4), e81–e89. https://doi.org/10.1590/s0066-782x2011005000022

Bundeszentrale für gesundheitliche Aufklärung (2011). *Verhütungsverhalten Erwachsener – Ergebnisse der Repräsentativbefragung [Contraceptive behavior of adults: Results of the representative study]*. BZgA. https://www.bzga.de/infomaterialien/sexualaufklaerung/sexualaufklaerung/verhuetungsverhalten-erwachsener-2011/

Bürkner, P. (2017). brms: An R package for Bayesian Multilevel Models using stan. *Journal of Statistical Software*, *80*(1), 1–28. https://doi.org/10.18637/jss.v080.i01

Ersek, J. L., Brunner Huber, L. R., Thompson, M. E., & Warren-Findlow, J. (2010). Satisfaction and discontinuation of contraception by contraceptive method among university women. *Maternal and Child Health Journal*, *15*(4), 497–506. https://doi.org/10.1007/s10995-010-0610-y

Fathizadeh, N., Salemi, P., & Ehsanpour, S. (2011). Dissatisfaction with contraceptive methods. *Iranian Journal of Nursing and Midwifery Research*, *16*(1), 79–82.

Fazekas, A., Senn, C. Y., & Ledgerwood, D. M. (2001). Predictors of intention to use condoms among university women: An application and extension of the theory of planned behavior. *Canadian Journal of Behavioural Science*, *33*(2), 103–117. https://doi.org/10.1037/h0087133

Fekadu, Z., & Kraft, P. (2002). Expanding the theory of planned behaviour: The role of social norms and group identification. *Journal of Health Psychology*, *7*(1), 33–43. https://doi.org/10.1177/1359105302007001650

Finegold, K. (2013). *New census estimates show 3 Million more Americans had health insurance coverage in 2012*. ASPE. https://aspe.hhs.gov/reports/new-census-estimates-show-3-million-more-americans-had-health-insurance-coverage-2012-0#:%20~:text=The%20key%20finding%20is%20that,to%20263.2%20million%20in%20201.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fraser, I. S. (1986). A health perspective of hormonal contraceptives. *Acta Obstetricia et Gynecologica Scandinavica*, *65*(s134), 33–43. https://doi.org/10.3109/00016348609157050

Frost, J. J., Singh, S., & Finer, L. B. (2007). Factors associated with contraceptive use and nonuse, United States, 2004. *Perspect Sex Reprod Health*, *39*(2), 90–99. https://doi.org/10.1363/3909007

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences*, *102*, 74–78. https://doi.org/10.1016/j.paid.2016.06.069

Hall, K. S., Castaño, P. M., & Westhoff, C. L. (2014). The influence of oral contraceptive knowledge on oral contraceptive continuation among young women. *Journal of Women's Health*, *23*(7), 596–601. https://doi.org/10.1089/jwh.2013.4574

Halpern, V., Lopez, L. M., Grimes, D. A., Stockton, L. L., & Gallo, M. F. (2013). Strategies to improve adherence and acceptability of hormonal methods of contraception. *The Cochrane Database of Systematic Reviews*, *10*, CD004317. https://doi.org/10.1002/14651858.CD004317.pub4

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2-3), 61–135. https://doi.org/10.1017/S0140525X0999152X

Higgins, J. A., & Hirsch, J. S. (2008). Pleasure, power and inequality: Incorporating sexuality into research on contraceptive use. *American Journal of Public Health*, *98*(10), 1803–1813. https://doi.org/10.2105/AJPH.2007.115790

Higgins, J. A., Hoffman, S., Graham, C. A., & Sanders, S. A. (2008). Relationships between condoms, hormonal methods and sexual pleasure and satisfaction: An exploratory analysis from the Women's Well-Being and Sexuality Study. *Sexual Health*, *5*(4), 321–330. https://doi.org/10.1071/sh08021

Higgins, J. A., Kramer, R. D., Wright, K. Q., Everett, B., Turok, D. K., & Sanders, J. N. (2022). Sexual functioning, satisfaction and well-being among contraceptive users: A three-month assessment from the HER Salt Lake Contraceptive Initiative. *Journal of Sex Research*, *59*(4), 435–444. https://doi.org/10.1080/00224499.2021.1873225

Higgins, J. A., & Smith, N. K. (2016). The sexual acceptability of contraception: Reviewing the literature and building a new concept. *Journal of Sex Research*, *53*(4–5), 417–456. https://doi.org/10.1080/00224499.2015.1134425

Hooper, D. J. (2010). Attitudes, awareness, compliance and preferences among hormonal contraception users. *Clinical Drug Investigation*, *30*(11), 749–763. https://doi.org/10.2165/11538900-000000000-00000

Inoue, K., Barratt, A., & Richters, J. (2015). Does research into contraceptive method discontinuation address women's own reasons? A critical review. *The Journal of Family Planning and Reproductive Health Care*, *41*(4), 292–299. https://doi.org/10.1136/jfprhc-2014-100976

International Institute for Population Sciences (IIPS) (2017). *National Family Health Survey (NFHS-4), 2015–16* (IND_2015_DHS_v01_M, Version 1) [Dataset]. IIPS. Mumbai, India. https://microdata.worldbank.org/index.php/catalog/2949/study-description#metadata-disclaimer_copyright

Jones, R. (2017). Change and consistency in US women's pregnancy attitudes and associations with contraceptive use. *Contraception*, *95*(5), 485–490. https://doi.org/10.1016/j.contraception.2017.01.009

Jones, R. (2018a). *Continuity and change in contraceptive use, United States, 2012-2014* (ICPSR 37067; Version V1) [Data set]. ICPSR. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR37067.v1

Jones, R. (2018b). *Continuity and change in contraceptive use, United States, 2012-2014* [Public-Use Dataset Users' Guide]. Inter-University Consortium for Political and Social Research. https://www.icpsr.umich.edu/web/DSDR/studies/37067/versions/V1/datadocumentation

Jones, R. (2018c). *Continuity and change in contraceptive use, United States, 2012-2014* [Data & Documentation]. Inter-University Consortium for Political and Social Research. https://www.icpsr.umich.edu/web/DSDR/studies/37067/datadocumentation

Kalia, P., Arora, R., & Kumalo, S. (2016). E-service quality, consumer satisfaction and future purchase intentions in e-retail. *e-Service Journal*, *10*(1), 24–41. https://doi.org/10.2979/ESERVICEJ.10.1.02

Kerns, J., Westhoff, C., Morroni, C., & Murphy, P. A. (2003). Partner influence on early discontinuation of the pill in a predominantly Hispanic population. *Perspectives on Sexual and Reproductive Health*, *35*(6), 256–260. https://doi.org/10.1111/j.1931-2393.2003.tb00178.x

Khan, S., Mishra, V., Arnold, F., & Abderrahim, N. (2007). *Contraceptive trends in developing countries* (Report No. 16). DHS Comparative Reports. Calverton, Maryland, USA: Macro International Inc. https://dhsprogram.com/pubs/pdf/CR16/CR16.pdf

Kui-Son, C., Woo-Hyun, C., Sunhee, L., Hanjoon, L., & Chankon, K. (2004). The relationships among quality, value, satisfaction and behavioral intention in health care provider choice: A South Korean study. *Journal of Business Research*, *57*(8), 913–921. https://doi.org/10.1016/S0148-2963(02)00293-X

Le Guen, M., Schantz, C., Régnier-Loilier, A., & de La Rochebrochard, E. (2021). Reasons for rejecting hormonal contraception in Western countries: A systematic review. *Social Science & Medicine*, *284*, 114247. https://doi.org/10.1016/j.socscimed.2021.114247

Linden, A., Mathur, M. B., & VanderWeele, T. J. (2020). Conducting sensitivity analysis for unmeasured confounding in observational studies using E-values: The evalue package. *The Stata Journal*, *20*(1), 162–175. https://doi.org/10.1177/1536867X20909696

Lindh, I., Hognert, H., & Milsom, I. (2016). The changing pattern of contraceptive use and pregnancies in four generations of young women. *Acta Obstetricia et Gynecologica Scandinavica*, *95*(11), 1264–1272. https://doi.org/10.1111/aogs.13003

Littlejohn, K. E. (2012). Hormonal contraceptive use and discontinuation because of dissatisfaction: Differences by race and education. *Demography*, *49*(4), 1433–1452. https://doi.org/10.1007/s13524-012-0127-7

Lüdecke, D. (2021). *sjPlot: Data visualization for statistics in social science*. R package version 2.8.10. https://CRAN.R-project.org/package=sjPlot

Malmborg, A., Persson, E., Brynhildsen, J., & Hammar, M. (2015). Hormonal contraception and sexual desire: A questionnaire-based study of young Swedish women. *The European Journal of Contraception & Reproductive Health Care*, *21*(2), 158–167. https://doi.org/10.3109/13625187.2015.1079609

Martin, D. S., O'Neill, M., Hubbard, S. S., & Palmer, A. (2008). The role of emotion in explaining consumer satisfaction and future behavioural intention. *Journal of Services Marketing*, *22*, 224–236. https://doi.org/10.1108/08876040810871183

Merki-Feld, G. S., Caetano, C., Porz, T. C., & Bitzer, J. (2018). Are there unmet needs in contraceptive counselling and choice? Findings of the European TANCO Study. *The European Journal of Contraception & Reproductive Health Care: The Official Journal of the European Society of Contraception*, *23*(3), 183–193. https://doi.org/10.1080/13625187.2018.1465546

Moreau, C., Bouyer, J., Bajos, N., Rodríguez, G., & Trussell, J. (2009). Frequency of discontinuation of contraceptive use: Results from a French population-based cohort. *Human reproduction*, *24*(6), 1387–1392. https://doi.org/10.1093/humrep/dep027

Moreau, C., Cleland, K., & Trussell, J. (2007). Contraceptive discontinuation attributed to method dissatisfaction in the United States. *Contraception*, *76*(4), 267–272. https://doi.org/10.1016/j.contraception.2007.06.008

Moreau, C., Hall, K., Trussell, J., & Barber, J. (2013). Effect of prospectively measured pregnancy intentions on the consistency of contraceptive use among young women in Michigan. *Human Reproduction*, *28*(3), 642–650. https://doi.org/10.1093/humrep/des421

Oddens, B. J. (1999). Women's satisfaction with birth control: A population survey of physical and psychological effects of oral contraceptives, intrauterine devices, condoms, natural family planning and sterilization among 1466 women. *Contraception*, *59*(5), 277–286. https://doi.org/10.1016/s0010-7824(99)00034-7

Peipert, J. F., Zhao, Q., Allsworth, J. E., Petrosky, E., Madden, T., Eisenberg, D., & Secura, G. (2011). Continuation and satisfaction of reversible contraception. *Obstetrics and Gynecology*, *117*(5), 1105–1113. https://doi.org/10.1097/AOG.0b013e31821188ad

R Core Team (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Rocca, C. H., Harper, C. C., & Raine-Bennett, T. R. (2013). Young women's perceptions of the benefits of childbearing: Associations with contraceptive use and pregnancy. *Perspectives on Sexual and Reproductive Health*, *45*(1), 23–31. https://doi.org/10.1363/4502313

Rohrer, J. M. (2019). Longitudinal data don't magically solve causal inference. *The 100% CI.* http://www.the100.ci/2019/04/16/longitudinal-data-dont-magically-solve-causal-inference/

Rohrer, J. M., & Lucas, R. E. (2020). Causal effects of well-being on health: It's complicated [preprint]. *PsyArXiv*. https://doi.org/10.31234/osf.io/wgbe4

Rubin, M. (2021). When to adjust alpha during multiple testing: A consideration of disjunction, conjunction and individual testing. *Synthese*, *199*, 10969–11000. https://doi.org/10.1007/s11229-021-03276-4 https://doi.org/10.1016/s0010-7824(01)00218-9

Simmons, R. G., Sanders, J. N., Geist, C., Gawron, L., Myers, K., & Turok, D. K. (2019). Predictors of contraceptive switching and discontinuation within the first 6 months of use among Highly Effective Reversible Contraceptive Initiative Salt Lake study participants. *American Journal of Obstetrics and Gynecology*, *220*(4), 376.e1–376.e12. https://doi.org/10.1016/j.ajog.2018.12.022

US Department of Labor (2013). *The employment situation – December 2012*. BLS. https://www.bls.gov/news.release/archives/empsit_01042013.pdf

US Government ASPE (2022). *HHS Poverty Guidelines for 2022* [Federal Register Notice]. ASPE. https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines

VanderWeele, T. J., & Ding, P. (2011). Sensitivity analysis in observational research: Introducing the E-value. *Annals of Internal Medicine*, *167*(4), 268–274.

VanderWeele, T. J., Mathur, M. B., & Chen, Y. (2020). Outcome-wide longitudinal designs for causal inference: A new template for empirical studies. *Statistical Science*, *35*, 437–4666. https://doi.org/10.48550/ARXIV.1810.10164

Vaughan, B., Trussell, J., Kost, K., Singh, S., & Jones, R. (2008). Discontinuation and resumption of contraceptive use: Results from the 2002 National Survey of Family Growth. *Contraception*, *78*(4), 271–283. https://doi.org/10.1016/j.contraception.2008.05.007

Villavicencio, J., & Allen, R. H. (2016). Unscheduled bleeding and contraceptive choice: Increasing satisfaction and continuation rates. *Open Access Journal of Contraception*, *7*, 43–52. https://doi.org/10.2147/OAJC.S85565

Weisberg, E., Bateson, D., Knox, S., Haas, M., Viney, R., Street, D., & Fiebig, D. (2013). Do women and providers value the same features of contraceptive products? Results of a best-worst stated preference experiment. *European Journal of Contraception & Reproductive Health Care: The Official Journal of the European Society of Contraception*, *18*(3), 181–190. https://doi.org/10.3109/13625187.2013.777830

Welling, L. L. M. (2013). Psychobehavioral effects of hormonal contraceptive use. *Evolutionary Psychology*, *11*(3), 718–742. https://doi.org/10.1177/147470491301100315

Westhoff, C. L., Heartwell, S., Edwards, S., Zieman, M., Stuart, G., Cwiak, C., Davis, A., Robilotto, T., Cushman, L., & Kalmuss, D. (2007). Oral contraceptive discontinuation: Do side effects matter? *American Journal of Obstetrics and Gynecology*, *196*(4), 412.e1–412.e7. https://doi.org/10.1016/j.ajog.2006.12.015

Woodside, A. G., Frey, L. L., & Daly, R. T. (1989). Linking service quality, customer satisfaction and behavioral intention. *Journal of Health Care Marketing*, *9*(4), 5–17.

Zethraeus, N., Dreber, A., Ranehill, E., Blomberg, L., Labrie, F., von Schoultz, B., Johannesson, M., & Hirschberg, A. L. (2016). Combined oral contraceptives and sexual function in women – a double-blind, randomized, placebo-controlled trial. *The Journal of Clinical Endocrinology and Metabolism*, *101*(11), 4046–4053. https://doi.org/10.1210/jc.2016-2032