

Supplement Table 1. Cross-sectional studies or retrospective case-control studies of pre-menopausal individuals

First Author (Reference #)	Publication Year	Study Design	Location of Study	Sample Size	Age of Participants	Study Period	Vaccine Types	Outcome(s)	Control Variables	Main Results	Overall Risk of Bias Rating
Abdollahi (1)	2022	Cross-sectional study	Iran	427	No age exclusions; mean age=29 years	6/2021-8/2021	Sinopharm, AstraZeneca, SputnikV, Covaxin	Menstrual disturbances, metrorrhagia, hirsutism	None	Menstrual disturbances: AstraZeneca 10.7%; SputnikV 5%, Covaxin 17.6%, Sinopharm 8%; Metrorrhagia: AstraZeneca 6.3%, SputnikV 2.5%, Covaxin 11.8%; Sinopharm 3.5% Hirsutism: AstraZeneca 3.6%, SputnikV 1.3%, Covaxin 2.9%, Sinopharm 0.5%	High
Aldali (2)	2022	Cross-sectional study	Riyadh, Saudi Arabia	604	16-17 years	12/2021-2/2022	Pfizer, Moderna	"Menstrual disorder"	None	Adolescents who took the first dose and had chronic disease had 2.4 times higher odds of having menstrual disorder than non-chronic disease patients.	High
Al-Furaydi (3)	2023	Cross-sectional study	Saudi Arabia	216	18-45 years	2/2022-3/2022	Pfizer, Moderna, AstraZeneca	Self-report of 8 possible menstrual changes: longer interval between menstruations, missed period, shorter interval between menstruations, more heavy bleeding than usual, less bleeding than usual, stronger pain during menstruation, less pain during menstruation, short menstruation Also asked if the changes persisted for 1, 2, or 3+ cycles	None	65% of participants reported at least one menstrual change Most common changes were longer intervals between menstruations (44%) and stronger pain during menstruation (33%).	High
Al-Mehaisen (4)	2022	Cross-sectional study	Global	1,506	≥18 years	5/2021-6/2021	Pfizer, Sinopharm, AstraZeneca, USSR	Changes in the menstrual cycle regularity, duration, volume (flow), new-onset dysmenorrhea, intermenstrual bleeding (IMB), or postcoital bleeding (PCB) in first period since receiving the vaccine.	None (pre-post comparison)	No effect estimates provided. 76% reported no changes in cycle duration and 60% reported no changes in days of flow. There were no new episodes of dysmenorrhea post vaccination. "The association between the date of the last vaccine dose with menstrual timing, duration, flow, and dysmenorrhea after vaccine and period timing and period volume was found to be statistically significant." There was no association of vaccine type with menstrual complaints, with exception of AstraZeneca being associated with dysmenorrhea.	High
Alvergne (5)	2023	Retrospective case-control study	UK	12,579	18-45 years	3/2021-6/2021	AstraZeneca and Pfizer	Perceived vaccine side effects on menses; FIGO classification system for AUB parameters: frequency, regularity, duration, volume, and inter-menstrual bleeding; cycle length; skipped menstrual periods; regularity; days of flow; intensity of flow; inter-menstrual bleeding.	Menstrual characteristics before pandemic, age, BMI, hormonal contraceptive use, reproductive disease	82% did not experience menstrual changes or "abnormal" cycle parameters (as defined by FIGO) after vaccination.	High
Amer (6)	2022	cross-sectional study	Saudi Arabia, Syria, Egypt, Libya, Sudan	1,254	15-50 years	5/2021-	Pfizer, Astrazeneca, Senopharm	Self-reported menstrual changes (amount, duration, symptoms)	None	38.4% reported menstrual changes, 27.8% reported amenorrhea 55.1% of menstrual changes were still present >9 months later	High
Baena-García (7)	2022	cross-sectional study	Spain	14,153	18-55 years	6/2021-9/2021	Pfizer-BioNTech, Moderna	Perceived changes in the amount and duration of menstrual	None	11,017 (78%) reported experiencing menstrual cycle changes after vaccination. The most common menstrual changes were more	High

							Oxford/AstraZeneca, and Johnson & Johnson/Janssen	bleeding, presence of clots, cycle length, and premenstrual symptoms after vaccine administration compared to the six previous menstruations (13 questions)		menstrual bleeding (43%), more menstrual pain (41%), delayed menstruation (38%), fewer days of menstrual bleeding (34.5%), and shorter cycle length (32%).	
Dabbousi (8)	2022	cross-sectional study	Lebanon	505	≥18 years	9/2021-10/2021	Pfizer, Astrazeneca, Sputnik, Sinopharm, Moderna	Heavy bleeding, light bleeding, pain, duration, regularity	None (pre-post comparison)	Heavy bleeding: 39.4% pre, 33.3% post Light bleeding: 26.7% pre, 33.5% post Pain: 75.4% pre, 75.2% post Duration: 7.9% pre, 9.9% post Irregular cycles: 12.5% pre, 20.4% post	High
Farland (9)	2023	cross-sectional study	US	545	18-45 years	5/2021-12/2021	Moderna, Pfizer, Janssen	Changes in menses since vaccination, when changes occurred (by dose), and when they resolved: missed periods, infrequent menstruation (>35 days), irregular menstruation, abnormal bleeding or spotting between the menstrual periods, abnormally light bleeding, abnormally heavy or prolonged bleeding, increased menstrual pain.	None	About 25% of vaccinated reported a change in their cycle after vaccination; most reported changes after their 2nd dose (56%) as compared with 1st (18%) and 3rd (14%) doses. Most common changes: irregular menses (43%), increased pain (30%), and abnormally heavy or prolonged bleeding (31%). Participants with a history of SARS-CoV-2 infection were less likely to report menstrual changes after vaccination vs. those without such history (OR=0.58; 95% CI: 0.32-1.04).	High
Filfilan (10)	2023	Cross-sectional study	Northern Africa, Middle East, Asia, Eastern Europe, Australia	2,381	15-49	1/2022-6/2022	Pfizer, Moderna, Astrazeneca, Janssen	Changes in cycle length, days of menstrual flow, dysmenorrhea, flow intensity, and intermenstrual bleeding	None	Changes in menstrual cycles were found for all types of vaccines. In 36% of vaccinated (2 doses), cycles became irregular, and in 29% of vaccinated (2 doses), cycles became prolonged (>35 days). Abnormalities were also experienced in the quantity of menstrual flow, with heavy flow reported in 31% of vaccinated. Severe dysmenorrhea was also a common post-vaccine menstrual change reported in 47% of vaccinated.	High
Gilan (11)	2023	Cross-sectional study	Israel	174	18-45 years	7/2021-11/2021	Pfizer-Biotech	Changes in amount or length of bleeding, intermenstrual bleeding and worsening in dysmenorrhea	BMI, age, background disease, hormonal treatment and parity.	Endometriosis patients were more likely to experience changes in bleeding patterns following vaccination (endometriosis: 39.5%, controls: 31.0%) and worsening in endometriosis symptoms with a 4.3-fold worsening in dysmenorrhea [95% CI 1.9-9.9]	High
Hariton (12)	2023	Cross-sectional study	US	5,314	18-55 years	3/3/2022-7/4/2022	Three exposure groups: not infected & not vaccinated (control), vaccinated but not infected, and infected but not vaccinated. Vaccine types: Pfizer, Moderna, Janssen	Users "Glow" app with a minimum of 6 months of continuous logging of menstrual cycles before and after April 2021. Primary outcome: changes in average cycle length and difference in cycle length in the 6 months before vs. each month after each event. Restricted to participants with cycles of 21-40 days.	Age, race, trying to conceive status, or symptoms associated with each event (results not shown)	No differences in average cycle length in the 6 months preceding or 6 months after vaccination. Participants with SARS-CoV-2 infection were more likely to report a longer first cycle after infection (0.35 days; 95% CI -0.15 to 0.56) than those without infection or vaccination, but difference was not clinically meaningful, and no difference observed in the month of infection or 2-6 months after infection.	Low

Kajiwara (13)	2023	cross-sectional study	Japan	55	18–22 years	10/2021-3/2022	Moderna, Pfizer	Regularity of menstruation; length of menstrual cycle; and day one date of menstruation around vaccination	None	Difference between predicted and actual menstrual cycle length was 1.9 ± 3.0 , 1.6 ± 2.8 , and 2.5 ± 3.8 days before vaccination and after 1st and 2nd dose of vaccine, respectively. In participants who received vaccinations twice within single menstrual cycle, this difference was 1.3 ± 3.5 and 3.9 ± 3.3 days before and after vaccination, respectively. Menstrual cycle length was slightly longer after 2nd dose.	Moderate
Khan (14)	2023	Cross-sectional study	Saudi Arabia	383	18-55 years	6/25/22-8/11/22	AstraZeneca, Pfizer, Moderna	Menstrual regularity, intermenstrual bleeding, menstrual flow, and menstrual pain	Age, PCOS, contraceptive use, identified vaccine skeptics	Reports of menstrual irregularity increased from 30% pre-vaccine to 70% post-vaccine, intermenstrual bleeding from 40% pre-vaccine to 60% post-vaccine, and extreme menstrual pain from 39% pre-vaccine to 61% post-vaccine. Women with PCOS reported greater menstrual pain post-vaccine. Vaccine skepticism was associated with greater reported menstrual changes post-vaccine.	High
Kumar (15)	2023	Cross-sectional study	India	5709	18-45 years	Not provided	COVISHIELD, COVAXIN	Frequent cycles, prolonged cycles, inter-menstrual bleeding, excessive bleeding, scanty bleeding, amenorrhea, cycle length, cycle regularity	None	333 (6%) reported post-vaccination menstrual disturbances, with 33% having frequent cycles, 64% prolonged cycles, and 4% inter-menstrual bleeding. 301 (5%) noticed changes in the amount of bleeding, with 50% excessive, 49% scanty, and 1% amenorrhea followed by heavy bleeding. Irregularities of menstrual cycle and length were higher in the COVAXIN group (7%) vs. COVISHIELD (5%) group.	High
Laganà (16)	2022	Cross-sectional study	Italy	164	mean age: 35.8 ± 7.2 years	9/10/2021-10/10/2021	AstraZeneca, Pfizer, Moderna, Janssen	frequency, length, and quantity of the menstrual cycle after vaccine administration	None	About 50-60% of participants who received the first dose of the COVID-19 vaccine reported menstrual cycle irregularities, regardless of the type of administered vaccine. Occurrence of menstrual irregularities seems to be slightly higher (60-70%) after the second dose. Menstrual irregularities after both 1st and 2nd doses resolved in ~50% of cases within two months.	High
Lee (17)	2022	Cross-sectional study	Not reported	39,129	18-45 years (pre-menopausal) 55-80 years (post-menopausal)	4/2021 - 6/2021	Pfizer, Moderna, AstraZeneca, Janssen, NovaVax, Other	Heavier menstrual flow Breakthrough bleeding	Age, race/ethnicity, postvaccine adverse effects of fever or fatigue, reproductive conditions, contraceptive hormone use, history of bleeding in pregnancy, history of postpartum hemorrhage	42% with regular menstrual cycles bled more heavily than usual, while 44% reported no change after being vaccinated. Among respondents who typically do not menstruate, 71% on long-acting reversible contraceptives, 39% of people on gender-affirming hormones, and 66% of postmenopausal participants reported breakthrough bleeding.	High
Lessans (18)	2023	Cross-sectional study	Israel	219	18-50 years	7/2021-10/2021	Pfizer, Moderna	Primary: irregular bleeding following vaccination. Secondary: presence of any menstrual change, including irregular bleeding, mood changes, or dysmenorrhea following the vaccine.	None (self-matched study)	Overall, 23.3% (n=51) experienced irregular bleeding and 40% (n = 83) reported any menstrual change after vaccination. Parity and presence of medical comorbidities were higher among patients who experienced irregular bleeding.	High

Marcelino (19)	2023	Cross-sectional study	Brazil	1012	20-39 years	12/31/21-2/8/22	Not reported.	Menstrual changes, menstrual cyclicity, days of menstrual flow, bleeding quantity	Age, ethnicity, cohabitation status, education, family income, contraception method, BMI, number of pregnancies, deliveries, and abortions, COVID infection	29.9% of women reported menstrual changes after vaccination. 9.4% reported irregular cycles, 19.2% reported changes to menstrual flow, and 18.8% reported changes to bleeding quantity. Contraceptive use was associated with fewer menstrual changes.	High
Martínez-Zamora (20)	2023	Cross-sectional study	Spain	848	>18 years (pre-menopausal)	9/2021-3/2022	Moderna, Pfizer-BioNTech	Worsened or new menstrual-associated symptoms in the first and second menstrual cycle after completed COVID-19 vaccination.	Age, hormonal treatment, smoking, parity	Similar % in both endometriosis and non-endometriosis groups reported menstrual changes the first (52.6% vs. 48.8%, respectively) and second cycle after vaccination (29.0% vs. 28.1%, respectively). Bleeding frequency/regularity disorders were found to be more frequent in the non-endometriosis group in the first cycle after vaccination.	High
Matar (21)	2023	Cross-sectional study	North Africa, Middle East	4,942	≥18 years	11/2021-12/2021	AstraZeneca, Janssen, Pfizer, Sinopharm, Sputnik	Heaviness of flow, cycle length, pelvic pain, days of bleeding	None	Heavy periods: 24.6% vs. 22.0% Cycle length >36 days: 1.6% in both groups; Pelvic pain: 83.8% vs. 81.6% Period-related pelvic pain in past three months: 85.3% vs. 81.6%	Moderate
Mínguez-Esteban (22)	2022	Cross-sectional study	Spain	746	18-45 years	2/2022-6/2022	Pfizer, Moderna	Menstrual pain intensity, menstrual bleeding, menstrual cycle duration	None	Sixty-five percent perceived changes in their menstrual cycle after vaccination, irrespective of type of vaccine or number of doses. An increase—rather than a reduction—in duration, bleeding, and pain during their menstrual cycles was reported after vaccination. The percentage that reported alterations after their last dose remained strongly constant across time, ranging from 64 to 65%.	High
Muhaidat (23)	2022	Cross-sectional study	MENA region	2,269	> menarche	7/2021-8/2021	Pfizer, Sinopharm, AstraZeneca	irregular menstruation, cramps, increased period frequency, menorrhagia, increased duration of menses, skipped periods, intermenstrual bleeding	None	35.3% of participants reported menstrual abnormalities pre-vaccination; 66.8% reported menstrual abnormalities after vaccination	High
Namiki (24)	2022	Cross-sectional study	Japan	309	≥18 years (premenopausal)	12/27/2021-3/5/2022	Pfizer, Moderna	Abnormal bleeding and menstrual irregularity.	None	The prevalence of abnormal bleeding was 0.6%, 1.0%, and 3.0% for the first, second, and third doses, respectively. Irregular menses were more common than abnormal bleeding: 1.9%, 4.9%, and 6.6% for the first, second, and third doses, respectively. COVID vaccination was not markedly associated with abnormal bleeding or irregular menstrual cycles.	High
Qazi (25)	2023	Cross-sectional study	India	300	15-49 years	11/20/2021-11/27/2021	Covaxin, Covishield	Cycle regularity, cycle length, heaviness of bleed, and menstrual pain	None	After vaccination, 10% experienced change in menstrual regularity (20% had a prolonged cycle, 30% had a missed cycle, 50% had delayed cycle) and 11% experienced change in cycle duration (55% had decreased duration, and 27% had increased duration). 33% reported cramps along with pain after vaccination. Duration of pain increased in 6% after vaccination. 25% reported change in menstrual flow after vaccination: increased flow (16%), decreased flow (59%).	High

Qashqari (26)	2022	Cross-sectional study	Saudi Arabia	2338	≥12 years (premenopausal)	8/2021-2/2022	Pfizer, AstraZeneca, and Moderna	Changes in heaviness of flow, cycle length, menstrual cramps.	None	>50% had not noticed any menstrual abnormalities after COVID vaccination. After receiving the first dose, small percentages reported that their next period was heavier than usual (14.5%), later than usual (27.7%), and cramps were worse than usual (26.5%). After receiving a second dose, small percentages reported that their period was heavier than usual (17.1%), later than usual (24.7%), and cramps were worse than usual (26.8%).	High
Rodríguez Quejada (27)	2022	Cross-sectional study	Online survey, 89% lived in South America	184	18-40 years	7/2021-9/2021	Pfizer, SinoVac, Janssen, Moderna, AstraZeneca, Other	Cycle regularity, menses length, bleed volume	None	- 51% regular, 43% irregular, 6% amenorrhea after vaccination - 65% normal duration of menses, 26% long menses, 9% amenorrhea/absent - 42% heavy bleeds, 21% light bleeds, 7% absent	High
Saleh Alzahrani (28)	2023	Cross-sectional study	Saudi Arabia	1066	12-50 years	12/2021-6/2022	Pfizer, AstraZeneca, and Moderna	Abnormal menstruation before vs. after COVID-19 vaccines, defined as shorter or longer cycle length, cycle irregularity, fewer or more days of flow, lighter or heavier intensity of flow, amenorrhea.	Occupation, gynecological conditions	Neither type of vaccine nor number of vaccine doses was associated with menstrual abnormality after vaccination.	High
Sarfraz (29)	2022	Cross-sectional study	Global	510	Not provided	6/2021-7/2021	Details not provided	Changes in cycle length	None	OR for change in cycle length of vaccinated vs. unvaccinated=3.17 (95% CI: 0.47, 21.43); only 3% of cohort unvaccinated	High
Sualeh (30)	2022	Cross-sectional study	Pakistan	384	≥18 years	11/2021-2/2022	Details not provided	Variations in flow, intensity, duration, or regularity of menses	None	After taking the COVID-19 vaccine, 33 participants (21.4%) reported a decrease in their menstrual cycle length. The menstrual flow of 40 participants (15.1%) became heavier.	High
Taşkaldiran (31)	2022	Cross-sectional study	Turkey	542	18-50 years	5/31/2022-7/31/2022	Pfizer, Sinovac, Other	Cycle shortened, cycle delayed, period shorter, period longer, bleeding lighter, bleeding heavier, intermenstrual bleeding	None	Shorter cycle=3.7%, delayed cycle=5.7%, intermenstrual bleeding=2.4%, heavier bleeding=3.7%, lighter bleeding=2.6%, shorter period=2.4%, longer period=2.9%	High

Abbreviations: AUB = abnormal uterine bleeding, β = mean difference, CI = confidence interval, OR = odds ratio, RR = relative risk, UK = United Kingdom, US = United States.

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