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Factors that Shape Women's Reproductive Decision-Making: A Scoping Review

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ABSTRACT. Women's reproductive decisions have profound impacts on the lives of women and society. While previous research has examined the outcomes and experiences of women's reproduction, less clear is the scope, range and type of research exploring factors shaping women's reproductive decisions. This scoping review of studies published between 2008 and 2018 examined evidence about the antecedents of women's reproductive decision-making to provide greater understanding of the factors shaping women's reproductive choices. Thematic analysis of 46 studies identified seven discrete, yet often inter-related, themes shaping women's reproductive decision-making: the process of reproductive decision-making; social, cultural and gender norms; health conditions, services and professionals; intimate partner violence; economic considerations; social support and relationships; and the passage of time.

Findings suggest women's reproductive decisions are highly contextual, occur over time and are often revisited, and are shaped by gendered and pronatalist norms, discourses and inequities. These findings emphasise the need to challenge inequitable gender structures and norms, and develop gender equitable health and social policy, to support women's reproductive decision making, and their health, wellbeing, and life ambitions in the context of their reproductive decisions. Further research is required to provide greater understanding of the factors that shape women's reproductive decisions.

Keywords: reproduction; decision-making; women's health; gender; reproductive decision-making; gender equity

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1. Introduction

Women's reproductive decisions have profound impacts on not only the lives of women but also society more broadly. Ensuring women have greater control over their reproductive decisions is a form of female empowerment and provides substantial improvements in women's health and wellbeing (Graham et al., 2016). While there is no universally agreed definition of "reproductive decision-making," many researchers and policy makers use the term, but notably, without providing clarification of what this term includes and excludes. For the purpose of this scoping review, the authors explored reproductive decision-making as the aspects of a woman's fertility regarding if and when to have a child or children; the timing, spacing and number of those children; and choices about whether or not to utilise mechanisms for controlling fertility including contraception, assisted reproduction, and abortion (Christopher, 1991).

Despite the importance of women's reproductive decision-making (WRDM), much of the literature focuses on examining women's outcomes and experiences of safer sex practices, pregnancy, choices regarding types of contraception or abortion implemented, or women's experiences of having and raising children (Chacko et al., 2016; Di Carlo et al., 2016; Flore et al., 2016; Lince-Deroche et al., 2017; Mansour, 2014; Melo et al., 2015; Newton et al., 2016). The aim of this scoping review was to examine the type and scope of available evidence on the antecedents of WRDM to identify and provide an understanding of the factors that shape women's reproductive choices.

1.2. Socio-Cultural Contexts for Women's Reproductive Decision-Making

WRDM is both experienced within, and pervaded by, broader socio-cultural discourses. Pronatalism is an ideology incorporating beliefs, attitudes and actions that, overtly or covertly, support parenthood and encourage fertility (Graham et al., 2016; Rich et al., 2011; Ulrich and Weatherall, 2000). For women, pronatalism manifests in ideologies, discourses and public policies that construct motherhood as natural and central to being a woman, and encourage a moral, patriotic, and economic obligation on women to have children. Under pronatalist discourses, the act and desire to mother are deemed central to womanhood and expressions of femininity (Gillespie, 2000; Park, 2002; Turnbull et al., 2016).

Situated within the broader socio-cultural discourse of pronatalism is women's reproductive autonomy and choice. Women's right to reproductive autonomy and choice has been a central part of the feminist movement and continues to be a critical part of feminist discourse, including women's right to control their own bodies, lives, and decisions regarding procreation and motherhood (Granzow, 2008; Wigginton et al., 2016). Despite this, women's reproductive decisions continue to be situated within a complex web of political, social and cultural ideologies (Graham et al., 2016). It is well recognised that the discourses and language of women's reproductive "choice" and "autonomy" can simplify and misrepresent what is a highly complicated and contested process for women. Women are required to navigate reproductive choices within social and political ideologies and structures that can constrain and restrict their decisions (Granzow, 2008; McCabe and Sumerau, 2017; Wigginton et al., 2016). Research has demonstrated women can be disempowered through policy, legislation and public discourse that restrict and critique their reproductive decisions (Graham et al., 2016).

Reproductive decision-making is often constructed as a gendered responsibility that falls on women, even though men can and do make reproductive decisions as individuals and members of couples (Fennell, 2011). The current scoping review focuses on the reproductive decision-making of women. In doing so, it does not suggest reproduction, family planning, contraceptive use or fertility are solely a woman's responsibility, thus inadvertently replicating inequitable gendered norms, stereotypes, and divisions of labour. The role and responsibility of men in reproductive decision-making is integral in supporting gender equitable roles and responsibilities for reproduction and contraceptive use in heterosexual sexual relations. However, it is critical this role is understood within, and seeks to support, women's reproductive and bodily autonomy, rights, choices, and decisions. Additionally, women of diverse gender and sexual identities are involved in making reproductive decisions, which may, or may not, involve or pertain to men. This scoping review explores the antecedents of WRDM, in recognition of the need for gender equity in reproductive responsibility and decision-making, for all women.

2. Methods

A scoping review was undertaken (Arksey and O'Malley, 2005; Munn et al., 2018) to examine the type and scope of available evidence on the antecedents of WRDM to identify and provide an understanding of the factors that shape women's reproductive choices. The search was limited to peer-reviewed, English language publications between 2008 and 2018. EBSCOHost was used to search: Academic Search Premier, CINAHL Complete, eBook Academic Collection, Education Source, Global Health, Health Policy Reference Center, Health Source – Consumer Edition, Health Source: Nursing/Academic Edition, MEDLINE Complete, Political Science Complete, PsycARTICLES, PsycBOOKS, PsycEXTRA, Psychology and Behavioral Sciences Collection, PsycINFO, and SocINDEX with Full Text.

The search strategy included the following key terms: decision-making OR empowerment OR autonomy OR decision* OR make decision* OR decision-making process OR choice* OR choose; reproduct* OR child bear* OR pregnan* OR prolificacy OR procreat* OR breed* OR conceive OR conception OR produce offspring OR progenerate OR gravid* OR fertili* OR beget OR impregnat* OR gestation; and antenatal OR prenatal OR termination OR abortion OR preventing pregnancy OR acceptable methods of birth control OR birth control OR contracept* OR abstinence OR family planning OR safe family planning OR acceptable methods of family planning OR affordable family planning. These key words were combined and the following limiter exclusions applied: sexual health or sexuality or sexual wellbeing, male reproductive health, animal*, developing countries or developing nations or third world or low-income countries, men's health, men or males or man or male, developed countr* or developed nation*.

Figure 1 shows the study selection process. The databases and search terms were developed and reviewed by all of the authors. Study selection was undertaken by all authors and each study was reviewed by at least two authors for inclusion. A total of 46 studies were included.

Data charting was then undertaken. This involved extracting and documenting information from the 46 studies identified including: author; year; country where the study was conducted; study design; data collection approach; sample size; participant socio-demographic characteristics; and key findings. A thematic analysis approach (Braun and Clarke, 2006) was undertaken to identify key concepts and factors relevant to the aim of the review. Concepts and factors were then reviewed to identify any similarities and were merged to develop themes, resulting in seven themes that shaped WRDM. While data charting provided a way in which to extract data, thematic analysis provides for a more nuanced and contextual understanding of the topic under examination rather than a profile of the included studies as a data chart (Arksey and O'Malley, 2005).

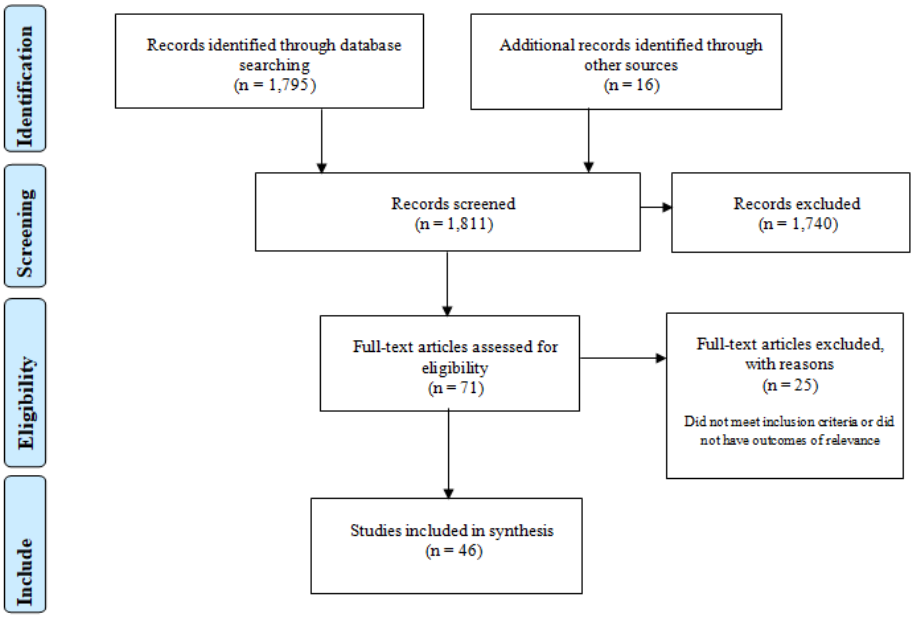


Figure 1 Study selection

3. Findings

Forty-six studies from the U.S., Canada, United Kingdom, Australia, New Zealand, Norway, Denmark, Israel, Bulgaria, China and the Republic of Korea met the inclusion criteria. Of the 46 studies, 21 were qualitative, 16 were quantitative, three were mixed methods, four were systematic reviews of quantitative or mixed method research, one was a literature review of mixed methods research, and one was a meta-synthesis of qualitative research. Forty-three of the studies included only women participants, while three studies included both women and men. Study sample sizes ranged from two to 10,003 participants. Participants' age ranged from 13 to 66 years. A diverse range of population groups were included in the samples; White/Caucasian (21), Black or African American (13), Hispanic/Latina (eight), Asian (eight), Multiracial (three), Aboriginal (two), African (one), Canadian (one), Indian (one), Israeli (one), Bulgarian (one) and Caribbean (one). Sexuality of participants was only reported in nine studies; heterosexual (six), lesbian (two) and bisexual (two).

This scoping review identified seven themes that shaped the antecedents of WRDM: the process of reproductive decision-making; social, cultural and gender norms; health conditions, services and professionals; intimate partner violence; economic considerations; social support and relationships; and the passage of time. These themes influenced WRDM both independently and

interactively. While WRDM was influenced by these themes, women's reproductive decisions also served to reinforce and perpetuate the themes in some situations.

3.1. The Process of Reproductive Decision-Making

Eight studies explored the process of reproductive decision-making through the application and testing of decision-making models and frameworks applied to women's reproductive intentions, choices and behaviours, and development of conceptual frameworks to explain WRDM processes.

The Traits-Desires-Intentions-Behavior (TDIB) model includes stable motivational dispositions (traits) that interact with cognitive constructs of desire (wants) and intentions (plans) to have a child, and how these in turn contribute to reproductive behaviour. Wagner et al. (2014) examined the fertility intentions and behaviour of women living with HIV in Canada using the TDIB model and found family support for trying to become pregnant, living in a large metropolitan city, women's fertility desires, and fertility intentions were all associated with pregnancy-seeking behaviour.

The Theory of Planned Behaviour (TPB) developed by Ajzen (1991) theorises how attitudes, subjective norms and perceived control combine to influence and predict decisions and behaviour (Williamson and Lawson, 2015). The TPB has increasingly been used to understand factors contributing to women's reproductive and fertility decisions (Kearney and White, 2016). Some research suggests discrepancies between women's fertility intentions and actual behaviour could be understood through the TPB, specifically, attitudes towards fertility, subjective norms, and perceived behaviour control (Luo and Mao, 2014). Several studies have used the TPB to examine women's fertility decisions specifically related to the timing of childbearing, including delayed childbearing. Quantitative research from Canada and Australia found the TPB could account for the variance in women's decisions to delay childbearing. Williamson and Lawson's (2015) Canadian quantitative research found among young women (mean age 21) subjective norms and perceived control all significantly contributed, accounting for 61% of the variance in women's intentions to delay childbearing past the age of 30. While the findings are limited to young women and thus not generalisable to women more broadly, the authors concluded the results provided preliminary support for the applicability of the TPB to account for women's intentions to delay childbearing. Similarly, Australian research by Kearney and White (2016) using the TPB demonstrated support for psycho-social predictors of attitude, pressure from others, and perceived self-confidence as predictors of women's intentions to delay childbearing (accounting for 55% of the total variance). The TPB and social network theories, were applied to an examination of intentions regarding the timing of parity progression for women and men aged 18–34 years in Bulgaria (Billari et al., 2009). This research

found the timing of parity-specific intentions was influenced by attitudes, norms, and perceived behavioural control, with normative pressure more relevant for intentions to become a first-time parent than intentions for subsequent children.

Three studies explored the process of decision-making through the development of decision-making conceptual frameworks and theories. Qualitative research with 20 American childfree women concluded women's decision-making followed two distinct pathways: some women made a conscious and certain decision to be childfree (deemed active deciders); and other women were framed as ambivalent toward motherhood or acceptance of the childfree life (deemed passive deciders) (Settle and Brumley, 2014). Lee and Zvonkovic's (2014) qualitative research identified a three-phased interactive process between married couples which occurred overtime in relation to decision-making: agreement (the initial decision by the man and woman to remain childfree and revisiting this decision over time); acceptance (solidification of the decision to remain childfree); and closing of the door (indefinite finalisation of the childfree status through sterilisation, medical reasons or age-related fertility limitations). Similarly, Blackstone and Stewart (2016) suggest the decision to not have children was of conscious design and the result of rationale and considered thinking, which occurred as a process over time and at multiple points across the life course.

3.2. Social, Cultural and Gender Norms

Social, cultural and gender-based norms were consistently identified across multiple studies as influencing WRDM. This included social and cultural norms of silencing and stigma regarding reproductive decisions like abortion. Moore's (2017) feminist qualitative research with women who were childless by choice and subsequently became mothers found the stigma associated with abortion, and the cultural norm of keeping abortions secret from others, influenced the women's decision to continue their pregnancies. Normative religious and spiritual discourses and beliefs also shaped decision-making. Leyva-Moral et al.'s (2018) systematic review found religious and spiritual beliefs and teachings played a role in the decision-making of many women living with HIV, influencing their decision to have a child or continue with their pregnancy. Qualitative research found Haredi Jewish women reported their own religious beliefs, and consulting with rabbis, as resources they draw upon to inform their reproductive decision-making regarding pregnancy, reproductive technologies, and prenatal testing (Teman et al., 2016).

Gender-based norms were found to influence WRDM. Four studies identified the norms and expectation that all women will have children. Young Aboriginal Australian women (Senior and Chenhall, 2012) who, despite reservations about becoming mothers, held fatalistic views regarding becoming pregnant at a young age due to observed social norms among their familial

and social networks. Despite this, they perceived it was their role to become a mother. Similarly, research involving Asian Indian immigrant women in America found women reported gender-based social pressures, and experiences of "community blame, familial nagging, and meddling," which they perceived left them with little reproductive decision-making ability. This pressure and interference were not directed equally at their male partners (Mann et al., 2017: 305). Normative gender expectations were found to be an influence in decision-making among American heterosexual and bisexual women (McCabe and Sumerau, 2017), and voluntarily childfree American women (Blackstone and Stewart, 2016). In Blackstone and Stewart's (2016) research, the women emphasised they had carefully considered their decision not to have children despite gendered expectations to do so. They chose not to conform to expectations of motherhood. For these women, gendered expectations still featured in their reflections of the reproductive decision-making process. However, it was in resistance to gendered norms, rather than conforming to them, that formed part of their experience. This highlights the multi-faceted nature of gender norms and expectations as an influence on women's reproductive intentions and aspirations.

Gendered norms regarding motherhood as a natural aspiration and goal for women and womanhood were observed in three studies, and shaped WRDM regarding having children. Esacove's (2008) narrative analysis of women's reproductive life histories found women's reproductive decisions were shaped by culturally embedded prescriptive ideals that women should, or do, feel a natural desire to have a child. Some women felt a sense of internal conflict when they deviate from these ideals and tend to draw on broader cultural explanations about gender norms to understand their personal experiences. Settle and Brumley (2014) similarly found that among a culturally-diverse sample of childfree women in the US, a lack of natural biological desire or maternal instinct shaped their decisions not to have children. In contrast, McCabe and Sumerau (2017) report some women adopted the common discourse of parenthood being natural for women, and defined their desire to become mothers as a natural and necessary part of fulfilment.

Four studies identified the broader societal notion of "good" motherhood as shaping WRDM, particularly if women felt they did not conform with or meet these expectations. For example, American childfree women cited not living up to the societal expectations of "good" motherhood by resistance to embracing a motherhood identity over other identities and emotional constraints which informed their decision to not have children (Settle and Brumley, 2014). Similarly, perceived ideals of motherhood, and women's self-assessment that they would not adequately meet these ideals, shaped women's decisions to place their child for adoption (Sisson, 2015). Gendered constructs of idealised motherhood were also found to shape women's

decisions to seek an abortion, with women reporting their inability to deliver ideal conditions of motherhood (Biggs et al., 2013). Qualitative research with American childless women who had elected to freeze their eggs found women who perceived intensive mothering (described as selfless and child-focused) as the only model of "good" mothering, reported their current circumstances would not allow them to meet this ideal, contributing to their decision to freeze their eggs (Myers, 2017).

Despite the overarching pronatalist ideology of western societies, social, cultural and gender norms contributed to discouraging some groups of women from mothering. This was evident in two studies that explored the experiences of women living with HIV. Women in these studies reported being discouraged by family and peers from having children in light of their HIV status, thus influencing their reproductive decisions including to undergo sterilisation (Jean et al., 2016; Raziano et al., 2017).

3.3. Health Conditions, Services and Professionals

Fifteen studies found health conditions were a factor influencing WRDM. Seven studies highlighted women's concerns about transmitting an illness to their child due to genetic or disease-based transmission factors, and concerns over birth defects because of the woman's treatment. One study explored the reproductive decision-making of women living with Sickle Cell Disease (SCD) and found the hereditary component of their condition was a significant factor shaping their reproductive decisions. This included whether to undertake prenatal genetic diagnosis for SCD, abortion, and requesting partners to undergo prospective genetic testing (Ross, 2015). A study of Korean women living with epilepsy found a quarter of participants reported they would have fewer children due to their epilepsy and had a heightened perception of their offspring's risk for developing epilepsy (Lee et al., 2013). In two studies involving women living with HIV, women reported undergoing tubal ligation as a preventative measure to prevent pregnancy due to concerns about their HIV positive status and the risk of mother-to-child transmission (Leyva-Moral et al., 2018; Raziano et al., 2017). Another qualitative study which explored women living with HIV in the United States found concerns about transmitting HIV to their child influenced their reproductive decision-making (Jean et al., 2016). For women who were breast cancer survivors, Hsieh et al.'s (2018) research identified women's concerns over passing cancer-positive genes to their child as a factor that shaped their reproductive decision-making. Women who perceived high risk and low benefit related to cancer and pregnancy were more inclined to act towards contraception, whereas women who perceived low risk and high benefit tended towards conceiving. The possibility of birth defects due to medications was also a concern identified by some women, shaping their decision not to have children (Tong et al., 2015).

Eight studies identified concerns about negative implications for the women's own health that might arise from pregnancy. Concerns about existing health conditions being exacerbated due to pregnancy was cited by women as one reason they decided not to have children (Jean et al., 2016; Tong et al., 2015), or to abort a pregnancy (Biggs et al., 2013; Kirkman et al., 2010). For women who had survived cancer, concerns about re-occurrence was a reason they had avoided conception or fertility preservation (Deshpande et al., 2015; Hsieh et al., 2018). Among those diagnosed with breast cancer or as carriers of the BRCA 1/2 gene, the need to commence treatment or preventative measures also influenced some women's decision to have fertility preservation measures undertaken or to have an abortion (Kirkman et al., 2013). Women who had cancer or who were identified as BRCA 1/2 carriers noted that these fertility decisions were often required to be made quickly which made the process more difficult and problematic (Brunstrom et al., 2016; Deshpande et al., 2015). This is discussed further in theme 3.7 "The Passage of Time."

Five studies identified women's interactions with health services and professionals as shaping their reproductive decisions. Two studies, McGrath et al's (2014) systematic review exploring pregnancy related information and knowledge of women with epilepsy, and Jean et al's (2016) qualitative research with American women living with HIV, found many women reported a lack of information from health professionals regarding their health conditions to support pregnancy planning. Deshpande et al.'s (2015) systematic review of women with a current or previous cancer diagnosis found women received conflicting information from health professionals during fertility planning. Similarly, two studies found receiving a lack of, or conflicting, contraceptive and fertility management information from health professionals negatively impacted their reproductive decision-making (Dixon et al., 2014; Kirkman et al., 2013).

Three studies found negative assumptions, attitudes, and discouragement from health professionals shaped WRDM. Women living with HIV (Leyva-Moral et al., 2018) and women living with Chronic Kidney Disease (Tong et al., 2015) both reported receiving negative responses and discouragement from health professionals regarding having children. Women in Tong et al's (2015) study described the warnings received as "traumatic, callous and overbearing" (58). These interactions negatively impacted some women's family planning decisions. For other women, the importance of motherhood superseded their negative experiences and they remained resolute in their decision to have a child. For women diagnosed with breast cancer, health professionals had both positively and negatively impacted their reproductive decision-making experience. Positive experiences included feeling listened to, respected, and supported in their plans to try for pregnancy or remain childfree. Negative experiences included unwarranted assumptions about their

fertility intentions or desires (based on their disease status, partner status, or age), which discouraged women and excluded them from their reproductive decision-making (Kirkman et al., 2013).

3.4. Intimate Partner Violence

Experiences of intimate partner violence (IPV) were found to influence WRDM regarding contraception, through coercion from partners (three studies), sterilisation (one study), and abortion (one study). In the quantitative study by Gee et al. (2009) involving 1,463 women, those who had experienced IPV were more likely to report going without contraception due to their partner's unwillingness to use it or wanting them to get pregnant. These women were also more likely to report having used emergency contraception. In a cross-sectional study involving 1,278 women, approximately a third of those surveyed who reported experiences of IPV also reported either pregnancy coercion to become pregnant or birth control sabotage (Miller et al., 2010). A New Zealand quantitative study with a random sample of 2,790 women also found women who had experienced IPV experienced reproductive coercion, including partner refusal to use condoms, and partners preventing women from using contraception (Fanslow et al., 2008). McCloskey et al.'s (2017) quantitative study with 278 women accessing family planning services found women with a history of IPV were more than twice as likely to decide to undergo permanent sterilisation compared with those without a violent partner. Côté and Lapierre's (2014) qualitative research exploring four women's experiences of abortion in the context of IPV found decision-making was a dynamic process. IPV strongly influenced these women's decision to have an abortion through: being pressured by the perpetrator to have an abortion; women's own concerns around the safety of the child; an anticipated lack of support they would receive from the abusive partner once the child arrived; fear of being criticised by others; concerns over losing the child to protection services; and the effects of psychological abuse which had undermined their confidence in their mothering capacity.

3.5. Economic Considerations

Six studies suggested economic considerations, in terms of financial goals and constraints, were influential in WRDM. A desire for financial stability was a key consideration and objective for women prior to conception in over 80% of a cohort of 863 female healthcare professionals in Denmark (Mortensen et al., 2012); and among women living with HIV in America (Jean et al., 2016). A meta synthesis of qualitative research examining factors influencing women's decisions to delay childbearing also identified a desire for financial security as a key factor (Cooke et al., 2010). Voluntary childless women perceived negative impacts of having children on their finances and

economic freedom (Blackstone and Stewart, 2016). A high value was placed on financial independence and a perception that motherhood involved financial risk and loss (Settle and Brumley, 2014). Childless women who subscribed to intensive mothering ideologies also reported the demands would be expensive, and they saw financial stability as a prerequisite to "good" motherhood. As discussed in theme 3.2 "Social, Cultural and Gender Norms," some women made the decision to freeze their eggs as a strategy to mitigate the risk of financial impacts that might compromise their accomplishment of "good" motherhood ideologies (Myers, 2017).

Three studies found women's concerns about their current financial problems, beliefs about the unaffordability of raising a child, the inability to afford health insurance, poor housing, and a poor economy were influencing factors (Biggs et al., 2013; Kirkman et al., 2009; Kirkman et al., 2010). Cost and affordability were also identified as the most commonly cited reason for female university students' non-contraceptive use (Brunner Huber and Ersek, 2009), and as a factor that shaped women's decisions to forgo fertility preservation measures when faced with a cancer diagnosis (Deshpande et al., 2015).

Five studies revealed career and education aspirations were factors that impacted WRDM through shaping decisions regarding contraceptive use, abortion, delaying childbearing, and choosing to not have children. A qualitative study with American women aged 35–49 years found some chose to avoid pregnancy, through contraceptive use, due to concerns that the responsibilities of motherhood would impact on their education and career aspirations (Godfrey et al., 2011). Another study with American women found approximately 20% of the sample (n = 954) reported they chose abortion because they felt a child at that time would interfere with their future study or career plans and opportunities (Biggs et al., 2013). Similarly, Settle and Brumley (2014) found women's decision to not have children was partly informed by women's high valuing of their ability to make choices about their education and career. These women believed motherhood was associated with a loss of freedom, autonomy, and a high level of responsibility, which would negatively impact on their education and career capacity. Career and education aspirations were also found to influence women's decisions and intentions to delay childbearing (Cooke et al., 2010; Kearney and White, 2016).

Three studies found a perceived lack of supportive workplace environments, that is workplaces conducive to balancing parenting and paid work responsibilities, shaped women's reproductive decisions. A survey with 835 Canadian women who had planned a pregnancy found one quarter of the women reported a lack of support for pregnant women at their workplace which influenced their decision about when to begin childbearing. Women also reported concerns about possible negative impacts of pregnancy on their careers, and conversely, possible negative impacts of their jobs on their preg-

nancy, influencing their decisions about when to have a child (Metcalfe et al., 2014). Similarly, a qualitative study of female athletic trainers found many of the women reported they planned to depart their profession entirely because they did not perceive their workplace setting was conducive to parenting (Mazerolle et al., 2015). For childless women who subscribed to intensive mothering ideologies, perceived unsupportive workplaces and the demands of long hours, lack of scheduling control, and extensive travel, were incompatible with their commitment to intensive mothering, and shaped their decisions to freeze their eggs and delay childbearing (Myers, 2017).

3.6. Social Support and Relationships

Five studies identified having an unstable relationship, or unsupportive partner, or a desire for a stable relationship, as factors that shaped reproductive decision-making (Biggs et al., 2013; Cooke et al., 2010; Kirkman et al., 2009; Kirkman et al., 2010; Mortensen et al., 2012). For women contemplating, or had decided to have an abortion, instability of their intimate partner relationship and their partner being unsupportive or unready for parenthood were factors that informed their decision (Biggs et al., 2013; Kirkman et al., 2009; Kirkman et al., 2010). Similarly, women's desire for a stable relationship influenced their decisions to delay childbearing or when to have a child (Cooke et al., 2010; Mortensen et al., 2012). For some single women, not wanting to raise a child without a partner was a factor that shaped their reproductive decision-making, including their decision to have an abortion, delay childbearing, or as a prerequisite for when they would want a child (Cooke et al., 2010; Kirkman et al., 2010; Mortensen et al., 2012). This highlights an interaction between experiences of social support and temporal factors (for example, decisions about parenthood in the context of relationship status at a particular point in time). Temporal factors are discussed further in the following theme, 3.7 "The Passage of Time."

Four studies suggested social support, being the emotional and material resources provided to an individual through interpersonal relationships, shaped WRDM as a positive mechanism. Research with breast cancer survivors reported women would have the courage to become pregnant if they thought they had substantial support and assistance from their family relationships (Hsieh et al., 2018). Similarly, for women living with HIV, perceived family support (including for some, the family's willingness to care for their child in the event of their death) was associated with their decisions regarding whether to have a child and their pregnancy-seeking behaviour (Leyva-Moral et al., 2018; Wagner et al., 2014). Reuter's (2018) small interpretative phenomenological analysis with two childless Canadian academics suggests "reproductive mentors" (114) can provide positive social support for reproductive decision-making.

Five studies identified that women's reproductive decisions can be affected by their perceptions of what family, friends, and society more broadly view as desirable. Women who had previously identified as childfree by choice but who unintentionally became pregnant and decided to have the child, reported they experienced pressure from their partners to have a child, which influenced their decision not to terminate the pregnancy (Moore, 2017). For women living with HIV, a lack of family support to become pregnant, including being labelled as immoral or careless, was a factor in the WRDM (Jean et al., 2016). Similarly, research with women living with HIV who had undergone sterilisation found one-fifth of participants reported feeling pressure from others to undergo sterilisation, with many women reporting they regretted their decision (Raziano et al., 2017). Research with women seeking abortion identified anticipated negative reactions or judgement from others, and experiences of pressure from family or friends to have an abortion, influencing the women's decisions to seek an abortion (Biggs et al., 2013). Concerns over anticipated negative reactions from others also shaped the reproductive decisions of women who had previously identified as childless by choice, but who later become mothers (Moore, 2017). These findings highlight a relationship between perceptions and experiences of social support and relationships, and aspects of social, cultural, and gender norms regarding some reproductive matters as discussed in theme 3.2 "Social, Cultural and Gender Norms."

Two studies specifically exploring women's decision-making process regarding abortion identified social relationships as a factor that shaped WRDM. In Kjelsvik and Gjengedal's (2011) qualitative phenomenological study, all participants reported they chose to involve the man with whom they had become pregnant, their friends, or family in their decision-making. However, some women reported a tension between their own choice and the pressure and influence of others' opinions in their decision-making process. Similarly, Wainer (2008) found most of the women in their study reported consulting with others as part of their decision-making process, including the biological father, their current partner, relatives, friends, and health professionals. The author identified three patterns of this decision-making and the involvement of others: collateral decision makers (women who avoided their usual networks and developed a new group of advisers); complimentary decision makers (women who added others to their usual network to inform their decision); and congenial decision makers (women who did not consult widely with others).

3.7. The Passage of Time

The passage of time was identified in eleven studies as influencing WRDM. Three studies explored women's biological clock and related fertility decline. Moore (2017) found some women attributed their change in attitude and

decision about having a child from a definitely "no" to a definitely "yes" due to awareness of their biological clocks, declining fertility, and self-described biological urges. Reuter's (2018) phenomenological study found despite being uncertain about their decision of whether or not to have a child, an awareness of their biological clocks and declining fertility, was a consideration in the women's reproductive decision-making. Conversely, Cooke et al. (2010) found some women perceived they had ample time to have a child due to advancements in fertility technology, and rejected age as a risk factor, and this belief partly shaped their decision to delay childbearing.

The notion of "wrong timing" regarding having a child was identified in four studies. Research with women who had or were considering aborting a pregnancy found wrong timing as one of the reasons influencing their decision to have an abortion. This included feeling they were too young, not ready for motherhood, or had other life plans that would be disrupted if they had a child at that time (which included study and career aspirations) (Kirkman et al., 2009; Kirkman et al., 2010). Thus, notions of timing (and particularly, "wrong timing") were interactive with aspects of theme 3.5 "Economic Considerations" such as education and career aspirations.

Wrong timing was also identified by women regarding pregnancy and advanced maternal age. This was further compounded for women experiencing particular health conditions, highlighting the interaction between this and aspects of theme 3.3 "Health Conditions, Services and Professionals." For example, for some women who had survived breast cancer, concerns about being pregnant at an advanced maternal age and associated risks of health problems for the child or mother negatively impacted on their decision (Hsieh et al., 2018). Concerns about advanced maternal age also informed women's decision to have an abortion, with some women reporting it was not the right time for a child due to concerns they were too old (Biggs et al., 2013).

Four studies reported the limited and often short time-periods in which women are forced to make decisions regarding abortion and fertility preservation, as factors shaping their reproductive decisions. Two studies exploring the experiences of women post breast cancer diagnosis noted women reported they were forced to make rapid and difficult decisions that had implications for fertility or childbearing. This included delaying treatment, starting chemotherapy, undertaking fertility preservation measures, or aborting a pregnancy, which shaped their decision-making and made it more complicated, overwhelming, and challenging (Deshpande et al., 2015; Kirkman et al., 2013). Additionally, two studies found limited time available to make reproductive decisions influenced decisions for women who had undergone or were contemplating abortions, with women reporting experiencing stress and despair due to having to make decisions quickly (Côté and Lapierre, 2014; Kjelsvik and Gjengedal, 2011). Additionally, women making the decision to

terminate a pregnancy in the context of IPV also reported they did not feel they had sufficient time to think through their options (Côté and Lapierre, 2014).

4. Discussion and Conclusion

This scoping review aimed to examine the available evidence on the antecedents of WRDM to provide a greater understanding of the factors that shape women's reproductive choices. The findings highlight WRDM is not only informed by personal desires and intentions, but is also shaped by physical, economic, temporal, relational, socio-cultural, and gendered, factors and structures. Notably, the factors and structures were often inter-related. For example, experiences of social support seemed to be contingent on social, cultural, and gender norms regarding reproductive issues and temporal factors intersected with economic factors and health conditions to influence WRDM. The findings also highlight women's reproductive decisions occur over time and are often revisited across the life course. Despite the variation across the included studies regarding the reproductive decision-making topic of focus, research methods, and participant sample, all contributed to identifying a range of factors that shape the antecedents of WRDM. These include experiences of intimate partner violence and reproductive coercion, health conditions, interactions with health professionals and services, economic factors, career and paid work considerations, social support and relationships, and social, cultural and gender norms. Significantly, this scoping review is the first to collectively examine WRDM evidence across the span of types of reproductive decisions, addressing a gap in prior research. The findings highlight the continuing influence of gendered norms, expectations, inequities, and pronatalist discourses in shaping WRDM. Further, the findings draw attention to the need to conceptualise WRDM beyond an idea of unconstrained choice, but rather, as situated within a range of intersecting physical, economic, temporal, relational, socio-cultural, and gendered influencing factors and constraints. Importantly, these factors and constraints emphasise the need for gender equitable health and social policy, and challenging inequitable gendered norms, to support women to make positive reproductive decisions that support their health, wellbeing, and life ambitions. Further research can assist with this to identify factors that support and constrain women's reproductive decisions. For example, longitudinal research will enable a greater understanding of the complex, interacting factors that constrain or facilitate WRDM over time and how reproductive decisions are influenced by changes in external forces, such as the policy context.

The studies included in the scoping review present some methodological limitations. Scoping reviews do not formally appraise the quality of evidence in the reviewed studies (Arksey and O'Malley, 2005). Twelve of the studies acknowledged their samples lacked cultural and racial diversity, which limits

the insights and generalisability of their findings to wider and more diverse populations of women. Sufficient information about the study participants was not provided in all studies, for example, in thirteen of the studies the ethnicity or sexuality of participants was not reported. This makes ascertaining the factors that shape the reproductive decision-making of different sub-groups of women, or comparing findings between studies, more difficult. The sample sizes in many of the qualitative studies were also small (with six studies having a sample of 10 or fewer participants), which while not uncommon in qualitative research, does present limitations in terms of sample diversity. Additionally, many of the quantitative studies used surveys composed of closed questions through predetermined items and scales, which may have limited the responses provided by women regarding what had informed their reproductive decisions. Lastly, most studies were undertaken with women at a single point in time; some examining current reproductive decisions or intentions, while others drew on retrospective accounts of women's decision-making. As studies in this scoping review have highlighted WRDM can be revisited and occurs over different points in time (Blackstone and Stewart, 2016; Lee and Zvonkovic, 2014). Yet the single point in time in which most research was undertaken may present a limitation. As such, findings can only be understood as indicative of the antecedents for women's reproductive decisions at that point in time, with recognition that these might, or might not, change over a woman's life course.

The limitations of this scoping review must also be acknowledged. Despite the comprehensive and systematic search strategy, which was designed and reviewed by all authors, studies of relevance to the review aim may have been missed. Consequently, the findings are a reflection of the analysis undertaken of the selected studies, and do not necessarily capture the complete range of factors that may shape the antecedents of WRDM. Furthermore, in the absence of an agreed definition of reproductive decision-making in the literature, the researchers undertaking this review conceptualised reproductive decision-making to include the aspects of a woman's fertility regarding if and when to have a child/children, the timing, spacing and number of those children, and choices about whether or not to utilise mechanisms for controlling fertility including contraception, assisted reproduction, and abortion. While this definition was used intentionally to enable the breadth and focus of the review, consequently, a diverse range of studies were included which explored women's decisions regarding contraception, abortion, fertility intentions, delaying childbearing, and voluntary childlessness, which shaped the themes and conclusions identified. A further scoping review could explore the range of definitions used in relation to reproductive decision-making. Three studies in the review included both women and men, which despite reporting on findings specific to women, may have also influenced the themes. Also, over a third of the studies included in the scoping review were from the U.S.,

which has a health care system with a focus on individual financing of medical care that is different from Australia, New Zealand, Canada, and the UK (also included in the review). This may have influenced the findings in terms of WRDM, and thus be another limitation.

Despite these limitations, this scoping review also has several strengths. A comprehensive systematic search strategy was used, guided by the research aim, which included a range of study designs. This adds to the depth of the literature discussed, also indicating the diverse, yet limited, nature of research in this area. Further, a broad definition of reproductive decision-making was used to account for the nuances that exist in this body of literature, and to capture the breadth of research that exists. Two reviewers extracted and reviewed the studies included, requiring consensus about the inclusion criteria adding strength to the method used. While not providing an appraisal of the quality of evidence may be seen as a limitation, the strength of the scoping review is that it can include a greater range of study designs and methodologies compared to a systematic review (Arksey and O'Malley, 2005). Finally, this scoping review provides important insight into the state of research exploring reproductive decision-making, whilst highlighting areas for future research.

Author contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Psychological and Physical Intimate Partner Violence during the COVID-19 Pandemic: Aggressive Attitudes, Abusive Behavior, and Coercive Control

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ABSTRACT. In this article, I cumulate previous research findings indicating that the risks of increased depression and anxiety symptoms are among individuals undergoing COVID-related abuse or reduced social support. I contribute to the literature on intimate partner violence by showing that abusive partners have increased harm during the COVID-19 outbreak by perpetrating psychological and physical intimate partner violence. Throughout May 2021, I performed a quantitative literature review of the Web of Science, Scopus, and ProQuest databases, with search terms including "intimate partner violence + COVID-19," "domestic violence + COVID-19," "family violence + COVID-19," and "abusive partners + COVID-19." Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. As I inspected research published in 2020 and 2021, only 348 articles satisfied the eligibility criteria. By eliminating controversial findings, outcomes unsubstantiated by replication, too imprecise material, or having similar titles, I decided upon 33, generally empirical, sources. Subsequent analyses should develop on economic stress and social isolation as risk determinants for intimate partner violence. Future research should thus investigate how COVID-19 lockdown policies have resulted in heightened rates of intimate partner violence and mental ill health. Attention should be directed to how elevated COVID-19-related stress is associated with intensified partner violence throughout the lockdown.

Keywords: intimate; partner; violence; COVID-19; pandemic; lockdown

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on intimate partner violence during the COVID-19 pandemic, and integrate the insights it configures on perceived stress, social isolation, and coercive control. By analyzing the most recent (2020–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that the COVID-19 outbreak articulates domestic violence against women. The actuality and novelty of this study are articulated by addressing COVID-19-specific stress (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021; Morrison and Lăzăroiu, 2021) related to elevated intimate partner violence victimization, that is an emerging topic involving much interest. My research problem is whether elevated COVID-19-related stress is associated with intensified partner violence throughout the lockdown.

In this review, prior findings have been cumulated indicating that the risks of increased depression and anxiety symptoms are among individuals undergoing abuse or reduced social support. The identified gaps advance COVID-19 lockdown conditions that stimulate coercive controlling behaviors. My main objective is to indicate that COVID-19-specific stress is related to elevated intimate partner violence victimization. This systematic review contributes to the literature on COVID-19-related intimate partner violence by clarifying that the COVID-19 pandemic has mainly impacted individuals having a history of exploitation, hostility, and ill-treatment.

This research endeavors to elucidate whether perpetrators' intentions to gain control and power by use of violence and coercive control have been amplified throughout the COVID-19 crisis. My contribution is by integrating research findings indicating that abusive partners have increased harm during the COVID-19 outbreak by perpetrating psychological and physical intimate partner violence.

2. Theoretical Overview of the Main Concepts

COVID-19 stay-at-home measures and social isolation have placed victims and survivors of domestic violence in imminent proximity to their abuser. An escalation in the risk degree and intricacy of COVID-19-related intimate partner violence comprises the manners that perpetrators have used the pandemic to put into practice power and control over their partner. COVID-19 stay-at-home orders and the related economic effects have brought about high intimate partner violence rates. COVID-19 stay-at-home orders have intensified exposure to abusive partners in terms of domestic violence and sexual assault. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), psychological and physical intimate

partner violence during COVID-19 lockdowns (section 4), COVID-19 lockdown conditions and coercive controlling behaviors (section 5), COVID-19 lockdown policies, intimate partner violence, and mental ill health (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "intimate partner violence + COVID-19," "domestic violence + COVID-19," "family violence + COVID-19," and "abusive partners + COVID-19." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2020 and 2021 was analyzed, only 348 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 33, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Intimate partner violence + COVID-19	180	18
Domestic violence + COVID-19	69	6
Family violence + COVID-19	58	5
Abusive partners + COVID-19	41	4
Type of paper		
Original research	288	29
Review	15	4
Conference proceedings	22	0
Book	6	0
Editorial	17	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Levels of physical and psychological intimate partner aggression perpetration have considerably escalated after the adoption of shelter-in-place restrictions that attempted to mitigate the spread of COVID-19.	Arenas-Arroyo et al., 2021; Goodman and Epstein, 2020; Lyons and Brewer, 2021; Parrott et al., 2021
The COVID-19 pandemic has mainly impacted minority women and individuals having a history of exploitation, hostility, and ill-treatment. Individuals experiencing intimate partner violence display decreased resilience and increased perceived stress.	Buttell et al., 2021; Davis et al., 2021; Kaukinen, 2020; Ragavan et al., 2021
COVID-19 stay-at-home orders and physical distancing have resulted in survivors being in immediate proximity to their abusers. COVID-19 social and economic marginalization in terms of housing instability constitutes a predictor of increased intimate partner violence.	Gresham et al., 2021; Peitzmeier et al., 2021; Williams et al., 2021
COVID-19 lockdown conditions stimulate coercive controlling behaviors. COVID-19 restrictive measures have led to the victim and the perpetrator living together for extended periods.	Almeida et al., 2020; Gulati and Kelly, 2020; Nesset et al., 2021; Smyth et al., 2021
Perpetrators have used the COVID-19 pandemic to put into practice power and control over their partner. Women's helplessnesses as regards violence have been intensified throughout the physical distancing and lockdown period.	Heward-Belle et al., 2021; Ojeahere et al., 2021; Sánchez et al., 2020
The COVID-19 outbreak articulates domestic violence against women. Increased time with their abusers has intensified victims' mental strain and cruel treatment.	Hsu and Henke, 2021; Kourti et al., 2021; Viveiros and Bonomi, 2021; Wood et al., 2021
The stay-at-home measures and social isolation have placed victims and survivors of domestic violence in imminent proximity to their abuser. COVID-19 large-scale lock- downs, decreased social support for victims, and economic distress have escalated the levels of family violence.	Connor et al., 2020; Piquero et al., 2021; Raj et al., 2020; Zhang, 2020
COVID-19 lockdown policies have resulted in heightened rates of intimate partner violence and mental ill health. The risks of increased depression and anxiety symptoms are among individuals undergoing abuse or reduced social support	Bambra et al., 2021; Iob et al., 2020; Schokkenbroek et al., 2021; Sharma and Borah, 2020
COVID-19 public health measures have amplified perpetrators' intentions to gain control and power by use of violence and coercive control.	Ali et al., 2021; Nnawulezi and Hacskaylo, 2021; Sorenson et al., 2021

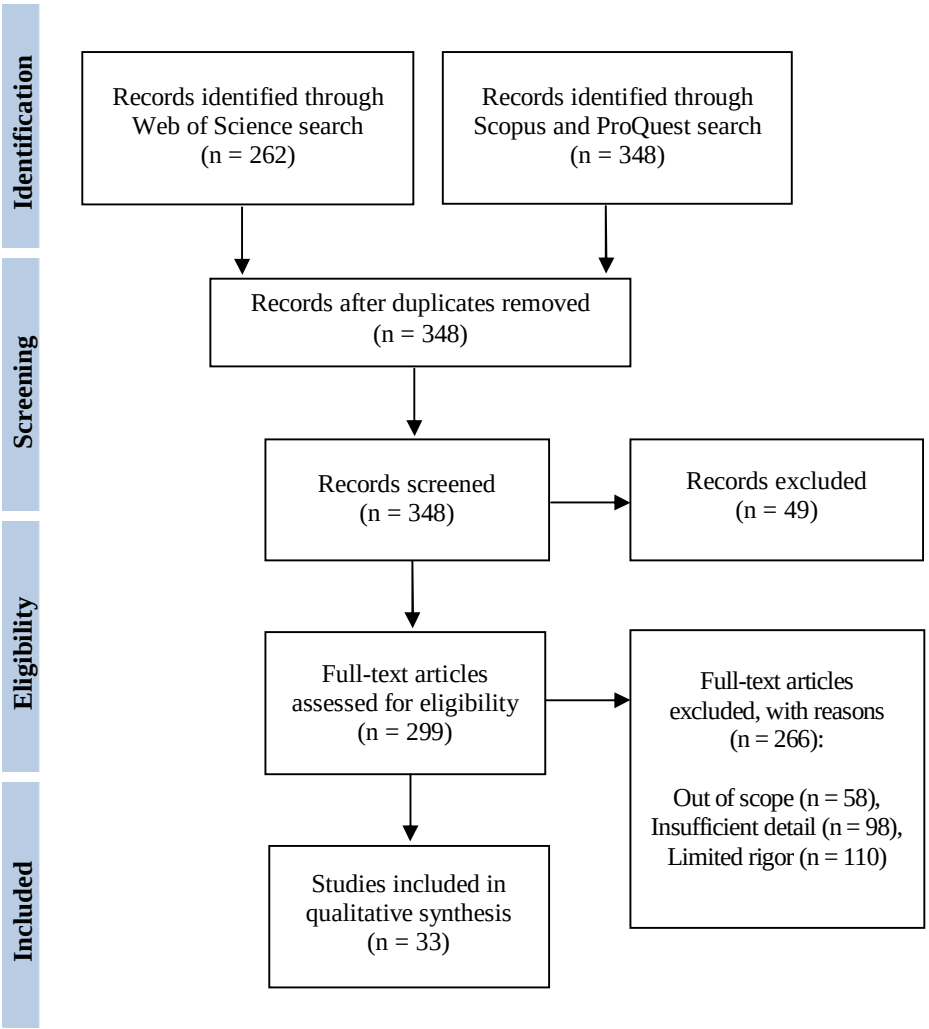


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.

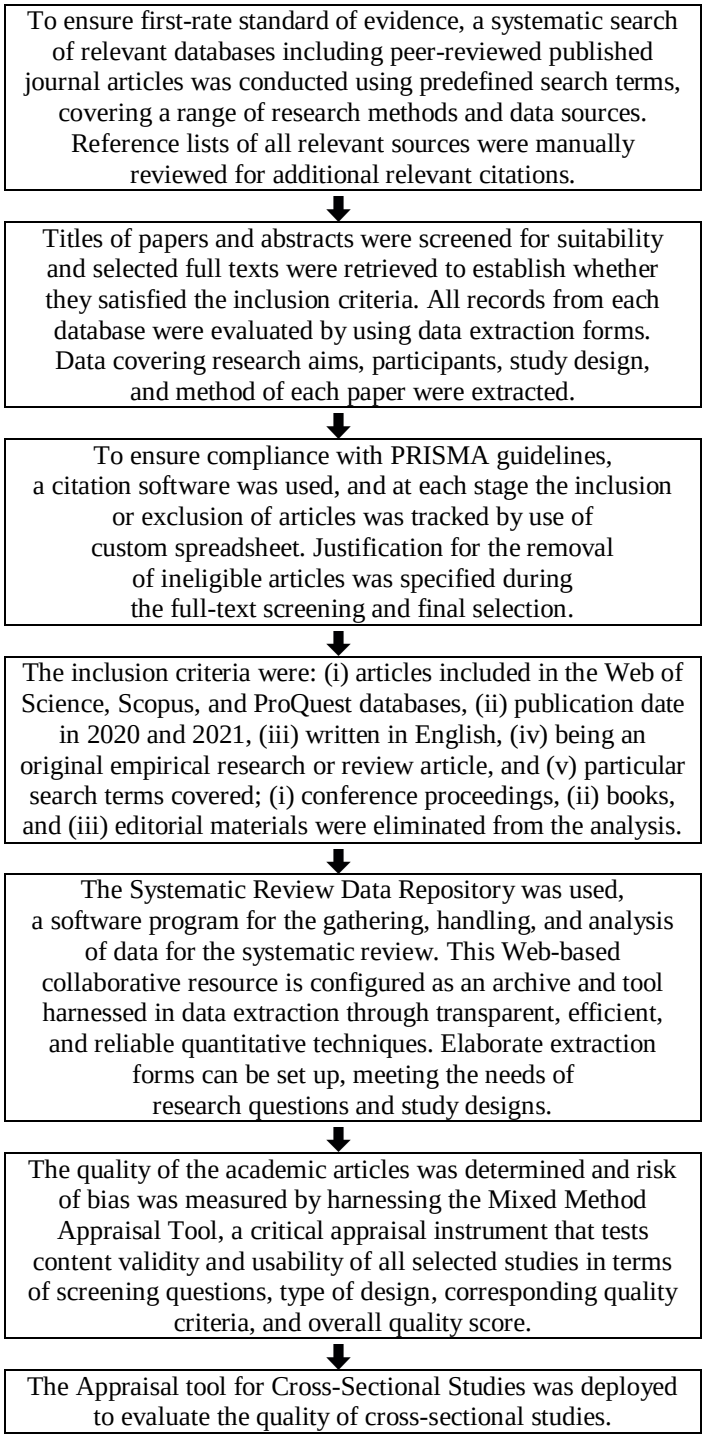


Figure 2 Screening and quality assessment tools

4. Psychological and Physical Intimate Partner Violence during COVID-19 Lockdowns

Levels of physical and psychological intimate partner aggression perpetration (Arenas-Arroyo et al., 2021; Goodman and Epstein, 2020; Lyons and Brewer, 2021; Parrott et al., 2021) have considerably escalated after the adoption of shelter-in-place restrictions that attempted to mitigate the spread of COVID-19. COVID-19 lockdown measures have discontinued some victims' intentions to dump their abusive partner. Intimate partner violence mainly increases, in terms of sexual and psychological abuse, as a result of COVID-19 lockdown, economic stress, health concerns, and working tensely in essential jobs. COVID-19 lockdowns have intensified the social isolation that domestic violence survivors have constantly undergone as a component of intimate partner abuse.

The COVID-19 pandemic has mainly impacted minority women and individuals having a history of exploitation, hostility, and ill-treatment (Buttell et al., 2021; Davis et al., 2021; Kaukinen, 2020; Ragavan et al., 2021), in addition to mental health issues, being employed by abusive partners to increase harm and perpetrate control. Individuals experiencing intimate partner violence display decreased resilience and increased perceived stress. Individuals who tested positive to COVID-19 or lost their job because of the pandemic tend to undergo or perpetrate psychological and physical intimate partner violence.

COVID-19 stay-at-home orders and physical distancing have resulted in survivors being in immediate proximity to their abusers (Gresham et al., 2021; Peitzmeier et al., 2021; Williams et al., 2021) while having limited access to resources and care. COVID-19 social and economic marginalization in terms of housing instability constitutes a predictor of increased intimate partner violence. Financial anxiety and health, social disconnection, increased levels of substance use, and COVID-19-specific stress are related to elevated intimate partner violence victimization. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Levels of physical and psychological intimate partner aggression perpetration have considerably escalated after the adoption of shelter-in-place restrictions that attempted to mitigate the spread of COVID-19.	Arenas-Arroyo et al., 2021; Goodman and Epstein, 2020; Lyons and Brewer, 2021; Parrott et al., 2021
The COVID-19 pandemic has mainly impacted minority women and individuals having a history of exploitation, hostility, and ill-treatment.	Buttell et al., 2021; Davis et al., 2021; Kaukinen, 2020; Ragavan et al., 2021
COVID-19 stay-at-home orders and physical distancing have resulted in survivors being in immediate proximity to their abusers.	Gresham et al., 2021; Peitzmeier et al., 2021; Williams et al., 2021

5. COVID-19 Lockdown Conditions and Coercive Controlling Behaviors

COVID-19 lockdown conditions stimulate coercive controlling behaviors (Almeida et al., 2020; Gulati and Kelly, 2020; Nesset et al., 2021; Smyth et al., 2021), restricting social contacts with household members, decreasing mobility, and facilitating perpetrators thoroughly keeping under surveillance their partner's actions. COVID-19 restrictive measures have led to the victim and the perpetrator living together for extended periods, with no possibility for the former to escape or leave. An increased risk of domestic violence with fundamental human rights of women being endangered has been related to COVID-19 infection-reducing measures. Intimate partner violence victims are generally women, with increased vulnerability to aggression perpetrators, while having decreased access to safe havens.

An escalation in the risk degree and intricacy of COVID-19-related intimate partner violence (Heward-Belle et al., 2021; Ojeahere et al., 2021; Sánchez et al., 2020) comprises the manners that perpetrators have used the pandemic to put into practice power and control over their partner. Women's helplessnesses as regards violence have been intensified throughout the physical distancing and lockdown period. Despondency, feelings of nonperformance, while being irascible and perpetually stressful constitute psychological symptoms considerably related to intimate partner violence amid the COVID-19 lockdown.

The COVID-19 outbreak articulates domestic violence against women (Hsu and Henke, 2021; Kourti et al., 2021; Viveiros and Bonomi, 2021; Wood et al., 2021), impacting reproductive rights and associated health routines. COVID-19 home confinement has resulted in continuous interaction between perpetrators and victims, and thus in elevated aggressiveness and reduced reports. COVID-19-related safety concerns, loneliness, absence of resources, and stay-at-home orders, together with decreased social networks and increased economic issues have triggered domestic violence and sexual assault. Increased time with their abusers has intensified victims' mental strain and cruel treatment. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

COVID-19 lockdown conditions stimulate coercive controlling behaviors. COVID-19 restrictive measures have led to the victim and the perpetrator living together for extended periods.	Almeida et al., 2020; Gulati and Kelly, 2020; Nesset et al., 2021; Smyth et al., 2021
Perpetrators have used the COVID-19 pandemic to put into practice power and control over their partner.	Heward-Belle et al., 2021; Ojeahere et al., 2021; Sánchez et al., 2020
The COVID-19 outbreak articulates domestic violence against women.	Hsu and Henke, 2021; Kourti et al., 2021; Viveiros and Bonomi, 2021; Wood et al., 2021

6. COVID-19 Lockdown Policies, Intimate Partner Violence, and Mental Ill Health

COVID-19 stay-at-home measures and social isolation (Connor et al., 2020; Piquero et al., 2021; Raj et al., 2020; Zhang, 2020) have placed victims and survivors of domestic violence in imminent proximity to their abuser who puts into practice power and coercive control. COVID-19 large-scale lockdowns, decreased social support for victims, and economic distress have escalated the levels of family violence. Time under COVID-19 shutdown is related to increased depression and anxiety symptoms, affecting persons with a history of intimate partner violence. The consequences of the COVID-19 outbreak are felt distressingly among women in terms of impecuniosity, housing insecurity, intimate partner violence, incarceration, and racism.

COVID-19 lockdown policies have resulted in heightened rates of intimate partner violence and mental ill health (Bambra et al., 2021; Iob et al., 2020; Schokkenbroek et al., 2021; Sharma and Borah, 2020), specifically affecting women. Elevated COVID-19-related stress regarding possible infection is associated with intensified partner violence throughout the lockdown, domestic violence constituting an indirect determinant of economic and social crisis. The risks of increased depression and anxiety symptoms are among individuals undergoing abuse or reduced social support, having unsatisfactory socioeconomic position, or having prior mental and physical health conditions.

COVID-19 public health measures have led to individuals experiencing escalated levels of stress and anxiety (Ali et al., 2021; Nnawulezi and Hacskaylo, 2021; Sorenson et al., 2021), amplifying perpetrators' intentions to gain control and power by use of violence and coercive control. COVID-19 stay-at-home orders and the related economic effects have brought about decreased shelter availability and high intimate partner violence rates, thoroughly compromising financial and housing stability. COVID-19 stay-at-home orders have intensified exposure to abusive partners in terms of domestic violence and sexual assault without supplying support for victims. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

The stay-at-home measures and social isolation have placed victims and survivors of domestic violence in imminent proximity to their abuser.	Connor et al., 2020; Piquero et al., 2021; Raj et al., 2020; Zhang, 2020
COVID-19 lockdown policies have resulted in heightened rates of intimate partner violence and mental ill health.	Bambra et al., 2021; Iob et al., 2020; Schokkenbroek et al., 2021; Sharma and Borah, 2020
COVID-19 public health measures have amplified perpetrators' intentions to gain control and power by use of violence and coercive control.	Ali et al., 2021; Nnawulezi and Hacskaylo, 2021; Sorenson et al., 2021

7. Discussion

I integrate my systematic review throughout research indicating how COVID-19 large-scale lockdowns, decreased social support for victims, and economic distress have escalated the levels of family violence. My research complements recent analyses clarifying how victims of intimate partner violence may be trapped in aggressive circumstances while sheltering in place during the COVID-19 pandemic. I elucidate, by cumulative evidence, previous research demonstrating how stay-at-home orders may result in victims of intimate partner violence spending increased time with their abusers, intensifying mental strain and cruel treatment.

8. Synopsis of the Main Research Outcomes

COVID-19 stay-at-home orders and physical distancing have resulted in survivors being in immediate proximity to their abusers. COVID-19 home confinement has resulted in continuous interaction between perpetrators and victims. Intimate partner violence mainly increases, in terms of sexual and psychological abuse, as a result of COVID-19 lockdown. Intimate partner violence victims are generally women, with increased vulnerability to aggression perpetrators.

9. Conclusions

Relevant research has investigated whether COVID-19 lockdowns have intensified the social isolation that domestic violence survivors have constantly undergone as a component of intimate partner abuse. This systematic literature review presents the published peer-reviewed sources covering COVID-19 public health measures that have led to individuals experiencing escalated levels of stress and anxiety. The research outcomes drawn from the above analyses indicate that levels of physical and psychological intimate partner aggression perpetration have considerably escalated after the adoption of shelter-in-place restrictions.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2020 and 2021, relevant sources on intimate partner violence during the COVID-19 pandemic in terms of perceived stress, social isolation, and coercive control may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles) discounting others (conference proceedings articles, books, and editorial materials). The scope

of my study also does not move forward the inspection of psychological symptoms considerably related to intimate partner violence amid the COVID-19 lockdown. Subsequent analyses should develop on economic stress and social isolation as risk determinants for intimate partner violence. Future research should thus investigate how COVID-19 lockdown policies have resulted in heightened rates of intimate partner violence and mental ill health. In the future, attention should be directed to how time under COVID-19 shutdown is related to increased depression and anxiety symptoms.

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*The National Agency for Equal Opportunities for Women and Men (*Romanian*, ANES) operates as a specialized institution of the central public administration, subordinated to the Ministry of Family, Youth, and Equal Opportunities, with legal personality, having responsibilities in developing, coordinating, and implementing governmental strategies and policies in the field of equality, opportunities, and treatment between women and men, and in the field of preventing and combating domestic violence. ANES's mission is to promote the principle of equal opportunities and treatment between women and men, in order to eliminate all forms of discrimination based on sex, and to prevent and combat domestic violence by implementing measures, policies, and programs tailored to the needs of victims. At present, ANES is partner with local authorities all over the country and coordinator for European projects concerning integrated services for victims in all counties of Romania (42 sheltered housing, with a capacity of 262 seats, 42 support groups, 42 vocational counseling offices) ("VENUS – Together for a safe life!"), opening 8 assistance centers for domestic aggressors ("Support for the implementation of the Istanbul Convention in Romania"), innovative measures on domestic violence that can be replicated at national level, by promoting key changes in the implementation of Council of Europe human rights standards ("VioGen – RoJust"), addressing multidisciplinary issues of domestic and gender violence, including specific measures of social, medical, educational, occupational, and housing assistance for at least 550 people (adults and children), victims of domestic and gender violence in rural and small urban areas ("GLORIA – integrated assistance for victims of domestic and gender violence"), facilitating access to emergency assistance for victims of domestic violence at risk through "panic button" devices ("Minerva"), issuing a number of recommendations for post-crisis measures concerning women's experiences and the obstacles they encountered during the COVID-19 crisis ("Women during and after Coronavirus: Information, Research, and Advocacy for Gender Equality") .

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Relational and Sexual Health during the COVID-19 Lockdown: Cognitive, Emotional, and Behavioral Disorders

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ABSTRACT. Despite the relevance of relational and sexual health during the COVID-19 lockdown, only limited research has been conducted on this topic. In this article, I cumulate previous research findings indicating that sexual activity and a gratifying sexual life have optimized physical health and quality of life throughout the COVID-19 pandemic. I contribute to the literature on sexual behavior and individuals' intimate lives by showing that the COVID-19 outbreak has intensified social isolation and depressive symptoms, shaping romantic relationships and sexual behavior. Throughout May 2021, I performed a quantitative literature review of the Web of Science, Scopus, and ProQuest databases, with search terms including "sexual health + COVID-19," "sexual activity + COVID-19," "sexual relation + COVID-19," "sexual behavior + COVID-19," and "sexual life + COVID-19." As I inspected research published in 2020 and 2021, only 378 articles satisfied the eligibility criteria. By eliminating controversial findings, outcomes unsubstantiated by replication, too imprecise material, or having similar titles, I decided upon 21, generally empirical, sources. Subsequent analyses should develop on COVID-19-related sexual functioning of individuals and couples. Future research should thus investigate how romantic and sexual experiences have optimized psychological well-being. Attention should be directed to how social and sexual contacts have been related to mental well-being during the COVID-19 pandemic.

Keywords: relational; sexual; health; COVID-19; lockdown; intimacy

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on relational and sexual health during the COVID-19 lockdown and integrate the insights it configures on cognitive, emotional, and behavioral disorders. By analyzing the most recent (2020–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that the COVID-19 outbreak has resulted in shifts in routines and norms as regards sexual relationship building and perpetuation. The actuality and novelty of this study are articulated by addressing how COVID-19-related lockdowns, social isolation, and physical distancing restrictions (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020) have impacted sexual behavior and individuals' intimate lives, that is an emerging topic involving much interest. My research problem is whether COVID-19-related stressors have negative affected family function and sexual relations between partners.

In this review, prior findings have been cumulated indicating that sexual activity and a gratifying sexual life have optimized physical health and quality of life throughout the COVID-19 pandemic. The identified gaps advance how regulations limiting mobility have impacted sexual health. Our main objective is to indicate that the COVID-19 outbreak has intensified social isolation and depressive symptoms, shaping romantic relationships and sexual behavior. This systematic review contributes to the literature on relational and sexual health during the COVID-19 lockdown by clarifying that COVID-19 lifestyle changes have been related to negative alterations in affected individuals' sex life. This research endeavors to elucidate whether individuals' emotional states brought about by the COVID-19-related lockdown and social isolation have impacted their sexual health and functioning. My contribution is by integrating research findings indicating that social and sexual contacts are related to mental well-being during COVID-19 containment measures.

2. Theoretical Overview of the Main Concepts

Sexual activity is pivotal in preserving physical health and emotional well-being. The COVID-19 crisis has brought about emotional distress, resulting in the development of mental and physical symptoms, and impacting the quality of sexual health. COVID-19 quarantine, physical distancing, and home confinement measures may aggravate sexual functioning of individuals and couples. Psychological and physical stressors as a result of the rate of the COVID-19 crisis and transmission have led to sexual behavior changes. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), COVID-19-related sexual behavior and individuals'

intimate lives (section 4), social and sexual contacts and mental well-being during COVID-19 containment measures (section 5), sexual behavior changes due to COVID-19-related psychological and physical stressors (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "sexual health + COVID-19," "sexual activity + COVID-19," "sexual relation + COVID-19," "sexual behavior + COVID-19," and "sexual life + COVID-19." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2020 and 2021 was analyzed, only 378 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/ inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 21, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Sexual health + COVID-19	99	6
Sexual activity + COVID-19	79	4
Sexual relation + COVID-19	69	4
Sexual behavior + COVID-19	67	4
Sexual life + COVID-19	64	3
Type of paper		
Original research	290	20
Review	46	1
Conference proceedings	22	0
Book	6	0
Editorial	14	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Sexual activity is pivotal in preserving physical health and emotional well-being.	Coombe et al., 2021; Jacob et al., 2020; Mollaioli et al., 2021
The COVID-19 outbreak has resulted in shifts in routines and norms as regards sexual relationship building and perpetuation.	Jenness et al., 2021; Kumar et al., 2021; Long et al., 2021
COVID-19-related lockdowns, social isolation, and physical distancing restrictions have led to escalated feelings of stress and seclusion. COVID-19-related stressors have negative affected family function and sexual relations between partners.	Feng et al., 2021; Herbenick et al., 2022; Lehmiller et al., 2021; Tan et al., 2021
Sexual activity and a gratifying sexual life optimize physical health and quality of life. Satisfactory incidence of sexual activity is associated with decreased psychological distress and improved relational and sexual health.	Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021
The COVID-19 outbreak has intensified social isolation and depressive symptoms, shaping romantic relationships and sexual behavior.	Gleason et al., 2021; Herbenick et al., 2022; Rosenberg et al., 2021; Wignall et al., 2021
COVID-19-related development of mental and physical symptoms has impacted the quality of sexual health. COVID-19 lifestyle changes have been related to negative alterations in affected individuals' sex life.	Hille et al., 2021; Lunt et al., 2021; Rodrigues and Lehmiller, 2021; Szuster et al., 2021
Individuals' emotional states brought about by the COVID-19-related lockdown and social isolation have impacted their sexual health and functioning. COVID-19 quarantine, physical distancing, and home confinement measures may aggravate sexual functioning of individuals and couples.	Carvalho and Pascoal, 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
The consequences of COVID-19 lockdown on psychological wellbeing are related to attitudes to casual sex. Increased perceived relevance of COVID-19 physical distancing has been related to reduced casual partner recurrence.	Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021
Psychological and physical stressors as a result of the rate of the COVID-19 transmission have led to sexual behavior changes. Physical distancing has impacted sexuality and relationships during the COVID-19 pandemic.	Bowling et al., 2021; Feng et al., 2021; Hille et al., 2021; Szuster et al., 2021

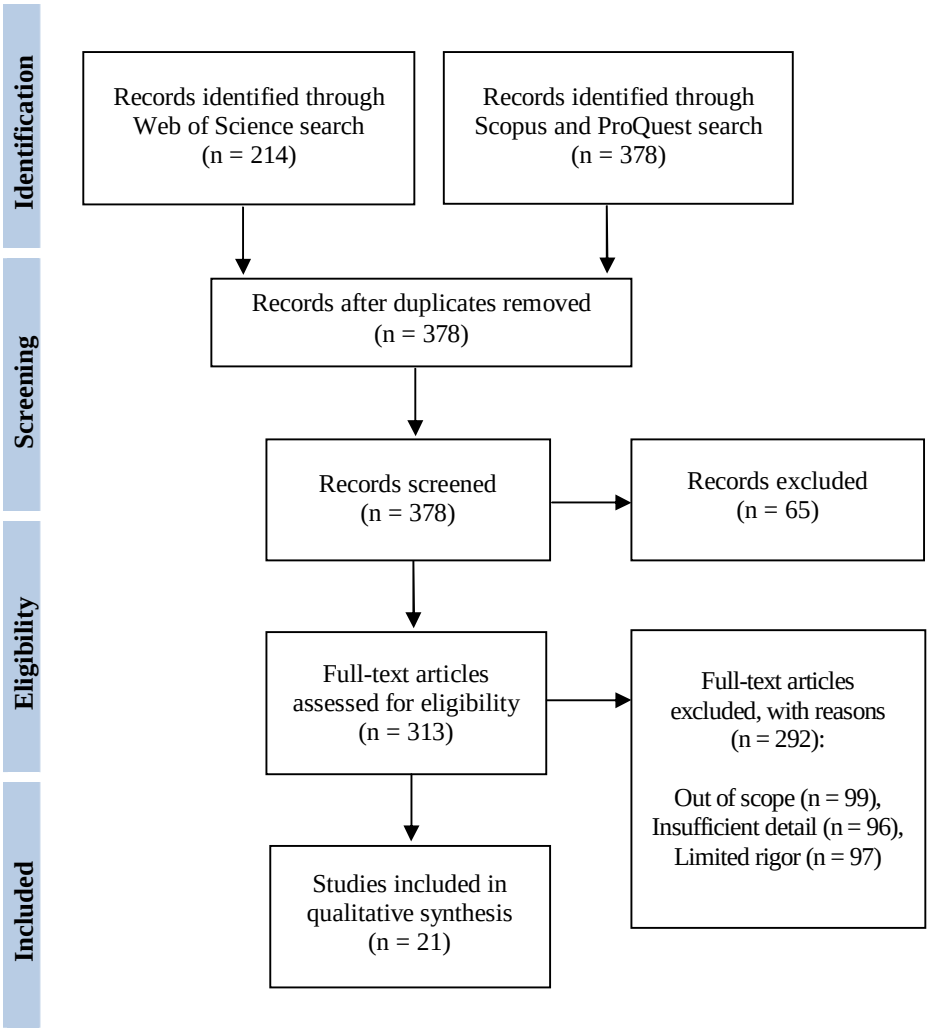


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

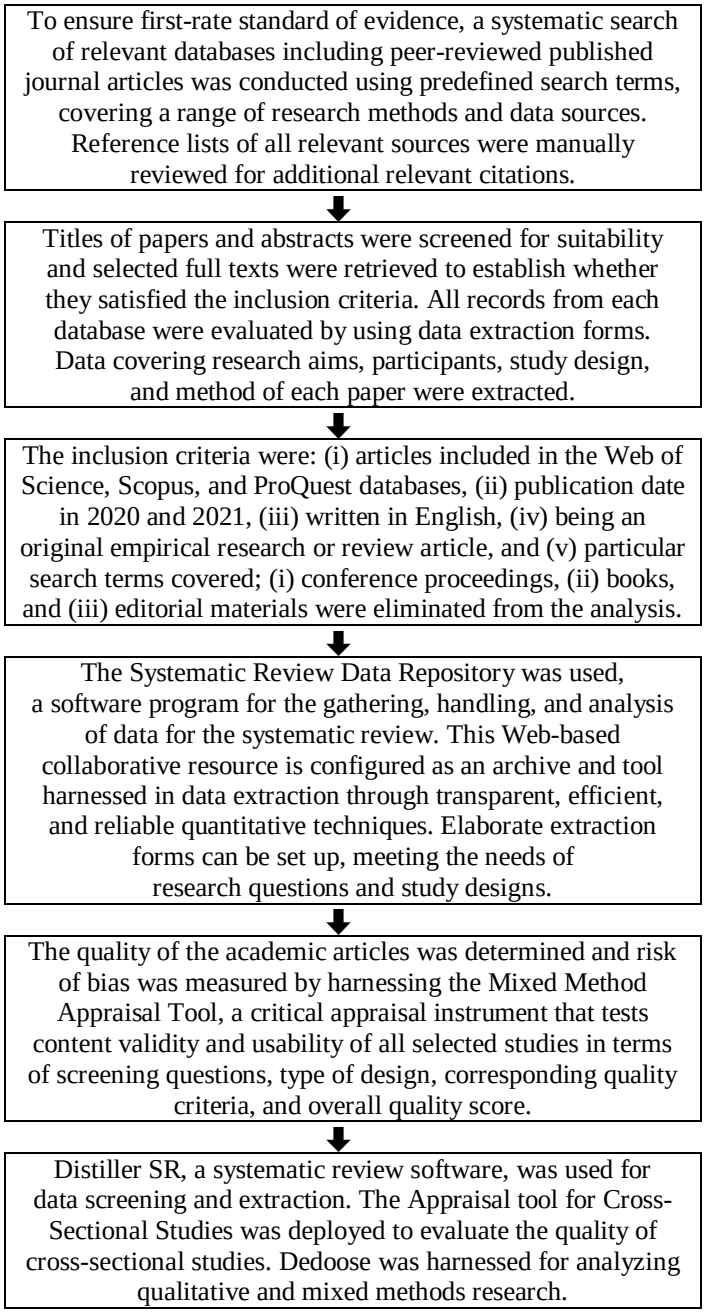


Figure 2 Screening and quality assessment tools

4. COVID-19-related Sexual Behavior and Individuals' Intimate Lives

Sexual activity is pivotal in preserving physical health and emotional well-being (Coombe et al., 2021; Jacob et al., 2020; Mollaioli et al., 2021): being a woman, absence of sexual activity and living without partner throughout the COVID-19 lockdown, age 40+, self-referred psychological symptoms, being provisionally without gainful employment are related to an escalated risk of developing anxiety and depression. Most single individuals have had less sex in contrast to persons being in a relationship during the COVID-19 lockdown.

The COVID-19 outbreak has resulted in shifts in routines and norms as regards sexual relationship building and perpetuation (Jenness et al., 2021; Kumar et al., 2021; Long et al., 2021), as affected people adjusted their behaviors and identified complementary manners of enacting sexual intimacy. The epidemiological consequences of behavioral reactions to COVID-19 require adequate sexual health messaging reinforcing sustainable behavior alterations. Regulations limiting mobility, the ensuing economic consequences on affected persons and families, and the necessity to relocate healthcare resources in relation to the COVID-19 pandemic have impacted sexual health.

COVID-19-related lockdowns, social isolation, and physical distancing restrictions have led to escalated feelings of stress and seclusion (Feng et al., 2021; Herbenick et al., 2022; Lehmiller et al., 2021; Tan et al., 2021), impacting sexual behavior and individuals' intimate lives. Individuals who are not living with their partners tend to experience a reduction in sexual satisfaction. As romantic and sexual experiences can optimize psychological well-being, the deprivation of routine physical contact with partners has led to deterioration in sexual health throughout the COVID-19 crisis. COVID-19-related stressors have negative affected family function and sexual relations between partners. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Sexual activity is pivotal in preserving physical health and emotional well-being.	Coombe et al., 2021; Jacob et al., 2020; Mollaioli et al., 2021
The COVID-19 outbreak has resulted in shifts in routines and norms as regards sexual relationship building and perpetuation.	Jenness et al., 2021; Kumar et al., 2021; Long et al., 2021
COVID-19-related lockdowns, social isolation, and physical distancing restrictions have led to escalated feelings of stress and seclusion. COVID-19-related stressors have negative affected family function and sexual relations between partners.	Feng et al., 2021; Herbenick et al., 2022; Lehmiller et al., 2021; Tan et al., 2021

5. Social and Sexual Contacts and Mental Well-Being during COVID-19 Containment Measures

Sexual activity and a gratifying sexual life optimize physical health and quality of life (Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021) throughout the COVID-19 pandemic. Inflexible COVID-19-related physical restrictions have influenced the likelihood of having additional sexual partners and unsafe sexual behaviors. Satisfactory incidence of sexual activity is associated with decreased psychological distress and improved relational and sexual health.

The COVID-19 outbreak has intensified social isolation and depressive symptoms (Gleason et al., 2021; Herbenick et al., 2022; Rosenberg et al., 2021; Wignall et al., 2021), shaping romantic relationships and sexual behavior. Individuals having unconstrained sociosexuality have experienced decreased levels of relational health and perceived consequences on subjective wellbeing, as a result of the confinements connected with casual sex to diminish COVID-19 transmission rates. Casual sex, sexual encounters, number of partners, and sexual enjoyment have been impacted by relationship status, depression symptoms, and perceived relevance of COVID-19 physical distancing measures: social and sexual contacts are related to mental well-being (e.g., quarantine, containment, and self-isolation).

The COVID-19 crisis has brought about emotional distress, resulting in the development of mental and physical symptoms (Hille et al., 2021; Lunt et al., 2021; Rodrigues and Lehmiller, 2021; Szuster et al., 2021), and impacting the quality of sexual health. The COVID-19 outbreak and physical distancing measures have led to sexual health services to attend to patients remotely. The sexual behavior of people has been altered throughout COVID-19 physical distancing measures in relation to reproductive purposes, the recurrence of partnered and individual sexual activities, and the assimilation of further routines into their sex life. COVID-19 lifestyle changes have been related to negative alterations in affected individuals' sex life, not associated with desiring to spend time with their partner, and positively related to relationship quality. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Sexual activity and a gratifying sexual life optimize physical health and quality of life.	Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021
The COVID-19 outbreak has intensified social isolation and depressive symptoms, shaping romantic relationships and sexual behavior.	Gleason et al., 2021; Herbenick et al., 2022; Rosenberg et al., 2021; Wignall et al., 2021
COVID-19-related development of mental and physical symptoms has impacted the quality of sexual health.	Hille et al., 2021; Lunt et al., 2021; Rodrigues and Lehmiller, 2021; Szuster et al., 2021

6. Sexual Behavior Changes Due to COVID-19-related Psychological and Physical Stressors

Individuals' emotional states brought about by the COVID-19-related lockdown and social isolation (Carvalho and Pascoal, 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021) have impacted their sexual health and functioning. The COVID-19 lockdown has intensely impacted the sexual health of the affected people. COVID-19 quarantine, physical distancing, and home confinement measures may aggravate sexual functioning of individuals and couples. Persons who have experienced increased disruptions to their lifestyle due to the COVID-19 crisis have undergone a decline in their sex life quality, but not in their relationship quality.

Individuals experiencing unsatisfactory mental health and feelings of loneliness throughout COVID-19 restrictions (Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021) are likely to reach out remote interpersonal connections. Women display decreased levels of sexual desire in contrast to men and their perceptions of the consequences of COVID-19 lockdown on psychological wellbeing are related to attitudes to casual sex. Increased perceived relevance of COVID-19 physical distancing has been related to reduced casual partner recurrence, while being single has been related to a diminution in volume of sexual partners.

Psychological and physical stressors as a result of the rate of the COVID-19 crisis and transmission have led to sexual behavior changes (Bowling et al., 2021; Feng et al., 2021; Hille et al., 2021; Szuster et al., 2021), especially an exacerbation in the occurrence of aggressiveness and risky sexual behaviors between partners, shaping their intimate relationships. Fear of contracting COVID-19, deterioration of health conditions, watching/reading media news, and isolation have affected mental and sexual health. Physical distancing has impacted sexuality and relationships during the COVID-19 pandemic. The prevalence of various sexual activities has deteriorated considerably for single and partnered individuals. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Individuals' emotional states brought about by the COVID-19-related lockdown and social isolation have impacted their sexual health and functioning.	Carvalho and Pascoal, 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
The consequences of COVID-19 lockdown on psychological wellbeing are related to attitudes to casual sex.	Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021
Psychological and physical stressors as a result of the rate of the COVID-19 transmission have led to sexual behavior changes.	Bowling et al., 2021; Feng et al., 2021; Hille et al., 2021; Szuster et al., 2021

7. Discussion

I integrate my systematic review throughout research indicating how the deprivation of routine physical contact with partners has led to deterioration in sexual health throughout the COVID-19 crisis. My research complements recent analyses clarifying how the sexual behavior of people has been altered throughout COVID-19 physical distancing measures in relation to reproductive purposes, the recurrence of partnered and individual sexual activities. I elucidate, by cumulative evidence, previous research demonstrating how the prevalence of various sexual activities has deteriorated considerably for single and partnered individuals.

8. Synopsis of the Main Research Outcomes

The COVID-19 lockdown has intensely impacted the sexual health of the affected people. The COVID-19 outbreak has intensified social isolation and depressive symptoms, shaping romantic relationships and sexual behavior. COVID-19-related lockdowns, social isolation, and physical distancing restrictions have impacted sexual behavior and individuals' intimate lives. The COVID-19 outbreak has resulted in shifts in routines and norms as regards sexual relationship building and perpetuation. Individuals' emotional states brought about by the COVID-19-related lockdown and social isolation have impacted their sexual health and functioning

9. Conclusions

Relevant research has investigated whether inflexible COVID-19-related physical restrictions have influenced the likelihood of having additional sexual partners and unsafe sexual behaviors. This systematic literature review presents the published peer-reviewed sources covering how COVID-19 affected people adjusted their behaviors and identified complementary manners of enacting sexual intimacy. The research outcomes drawn from the above analyses indicate that physical distancing has impacted sexuality and relationships during the COVID-19 pandemic.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2020 and 2021, relevant sources on relational and sexual health during the COVID-19 lockdown may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles) discounting others (conference proceedings articles, books, and editorial materials).

The scope of our study also does not move forward the inspection of unsafe sexual behaviors during the COVID-19 lockdown. Subsequent analyses should develop on COVID-19-related sexual functioning of individuals and couples. Future research should thus investigate how romantic and sexual experiences have optimized psychological well-being. Attention should be directed to how social and sexual contacts have been related to mental well-being during the COVID-19 pandemic.

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COVID-19-related Psychosocial Stressors, Sexual Behaviors, and Quality of Life

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ABSTRACT. This article reviews and advances existing literature concerning COVID-19-related psychosocial stressors, sexual behaviors, and quality of life. With growing evidence of psychological well-being, intimate relationships and sexual behaviors during the COVID-19 lockdown, there is a pivotal need for comprehending relationship tension because of COVID-19 transmission and restrictions. In this research, previous findings were cumulated showing that absence of sexual activity throughout the COVID-19 crisis is related to a considerably increased risk of developing anxiety and depression and contribute to the literature by indicating that quarantine, physical distancing, social isolation, and home confinement-related stress and anxiety may increase sexual issues. Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was performed, with search terms including "sexual activity + COVID-19," "sexual health + COVID-19," "sexual practice + COVID-19," "sexual behavior + COVID-19," "sexual relationship + COVID-19," and "sexual life + COVID-19." As research published between 2020 and 2021 was inspected, only 366 articles satisfied the eligibility criteria. By taking out controversial or ambiguous findings (insufficient/irrelevant data), outcomes unsubstantiated by replication, too general material, or studies with nearly identical titles, I selected 21 mainly empirical sources. Subsequent analyses should develop on sexual functioning and relationship satisfaction concerning physical and mental well-being during the COVID-19 social lockdown. Future research should thus investigate COVID-19-related detrimental sexual and reproductive health outcomes. Attention should be directed to sexual frequency and relationship satisfaction throughout COVID-19 social restrictions.

Keywords: COVID-19; psychosocial; stressor; sexual; behavior; health

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on COVID-19-related psychosocial stressors, sexual behaviors, and quality of life and integrate the insights it configures on psychological well-being, intimate relationships and sexual behaviors during the COVID-19 lockdown. By analyzing the most recent (2020–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that sexual activity can mitigate COVID-19-related psychosocial stressors. The actuality and novelty of this study are articulated by addressing COVID-19-related sexual functioning and relationship satisfaction, that is an emerging topic involving much interest. My research problem is whether COVID-19-related psychological adjustment, loneliness, and situational life stressors have influenced individuals' sexual health.

In this review, prior findings have been cumulated indicating that quarantine, physical distancing, social isolation, and home confinement-related stress and anxiety (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Mihăilă, 2018) may increase sexual issues. The identified gaps advance sexual behavior and satisfaction due to COVID-19 movement control measures. My main objective is to indicate that measures to reduce the consequences of the COVID-19 pandemic may hinder the development of healthy sexual relationships. This systematic review contributes to the literature on COVID-19-related psychosocial stressors, sexual behaviors, and quality of life (Lyons and Lăzăroiu, 2020; Mihăilă, 2017; Mitchell and Lăzăroiu, 2021) by clarifying that absence of sexual activity throughout the COVID-19 crisis is related to a considerably increased risk of developing anxiety and depression. This research endeavors to elucidate whether relationship tension because of COVID-19 transmission and restrictions (Mihăilă et al., 2016; Morrison and Lăzăroiu, 2021) is consistently predictive of anxiety, depression, and loneliness. My contribution is by integrating research findings indicating that sexual activity is protective to COVID-19 quarantine-related anxiety, depression, and relational issues.

2. Theoretical Overview of the Main Concepts

During the COVID-19 outbreak, sexually active subjects display decreased anxiety and depressive symptoms. The COVID-19 lockdown measures have influenced the incidence of diverse partnered and solitary sexual behaviors and activities. COVID-19-related increased sexual desire, social isolation, and stress can result in intensified sexual variations to satisfy psychological needs or alleviate negative mood states. Alterations in sexual behavior as a result of COVID-19 physical distancing measures have impacted relationship satisfaction. Fear, unpredictability, and anxiety are associated with restrictions

of individuals' activities in lockdown, with consequences to sexual satisfaction. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), psychological well-being, intimate relationships and sexual behaviors during the COVID-19 lockdown (section 4), COVID-19-related sexual functioning and relationship satisfaction (section 5), sexual behavior and satisfaction due to COVID-19 movement control measures (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "sexual activity + COVID-19," "sexual health + COVID-19," "sexual practice + COVID-19," "sexual behavior + COVID-19," "sexual relationship + COVID-19," and "sexual life + COVID-19." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2020 and 2021 was analyzed, only 366 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 21, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Sexual activity + COVID-19	62	3
Sexual health + COVID-19	72	6
Sexual practice + COVID-19	66	3
Sexual behavior + COVID-19	63	4
Sexual relationship + COVID-19	54	3
Sexual life + COVID-19	49	2
Type of paper		
Original research	292	20
Review	28	1
Conference proceedings	26	0
Book	4	0
Editorial	16	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Sexual activity affects psychological health, the immune response, and cognitive function positively, and can mitigate COVID-19-related psychosocial stressors.	Jacob et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
COVID-19-related psychological adjustment, loneliness, and situational life stressors have influenced individuals' sexual health.	Carvalho et al., 2021; Dema et al., 2022; Kumar et al., 2021; Wignall et al., 2021
COVID-19 social restrictions have considerably disrupted sexual practices and the quality of sex lives. The COVID-19 outbreak has impacted psychological well-being, intimate relationships and sexual behaviors.	Herbenick et al., 2022; Hille et al., 2021; Lehmiller et al., 2021; Tan et al., 2021
Measures to reduce the consequences of the COVID-19 pandemic may hinder the development of healthy sexual relationships. Sexual activity, prevalence, and risky behaviors have deteriorated during the COVID-19 lockdown.	Karp et al., 2021; Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
The COVID-19 lockdown measures have influenced the incidence of diverse partnered and solitary sexual behaviors and activities. Relationship tension because of COVID-19 transmission and restrictions is consistently predictive of anxiety, depression, and loneliness.	Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021
Sexual function is affected by COVID-19-related mental health, thus impacting quality of life. Fear, unpredictability, and anxiety are associated with restrictions of individuals' activities in lockdown, with consequences to sexual satisfaction.	Effati-Daryani et al., 2021; Feng et al., 2021; Hille et al., 2021; Omar et al., 2021; Szuster et al., 2021
Sexual desire and sexual behaviors have been reconfigured during the COVID-19 social lockdown. Absence of sexual activity throughout the COVID-19 crisis is related to an increased risk of developing anxiety and depression.	Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Wignall et al., 2021
Sexual activity is protective to COVID-19 quarantine-related anxiety, depression, and relational issues. Depression symptoms are associated with declines in sexual enjoyment and casual sex.	Gleason et al., 2021; Lehmiller et al., 2021; Mollaioli et al., 2021
Modifications in sexual behavior and satisfaction due to COVID-19 movement control measures differ according to affected persons' partnership status and living arrangements. Alterations in sexual behavior as a result of external stressors (e.g., physical distancing measures) have impacted relationship satisfaction.	Bowling et al., 2021; Hille et al., 2021; Rodrigues and Lehmiller, 2021; Tan et al., 2021

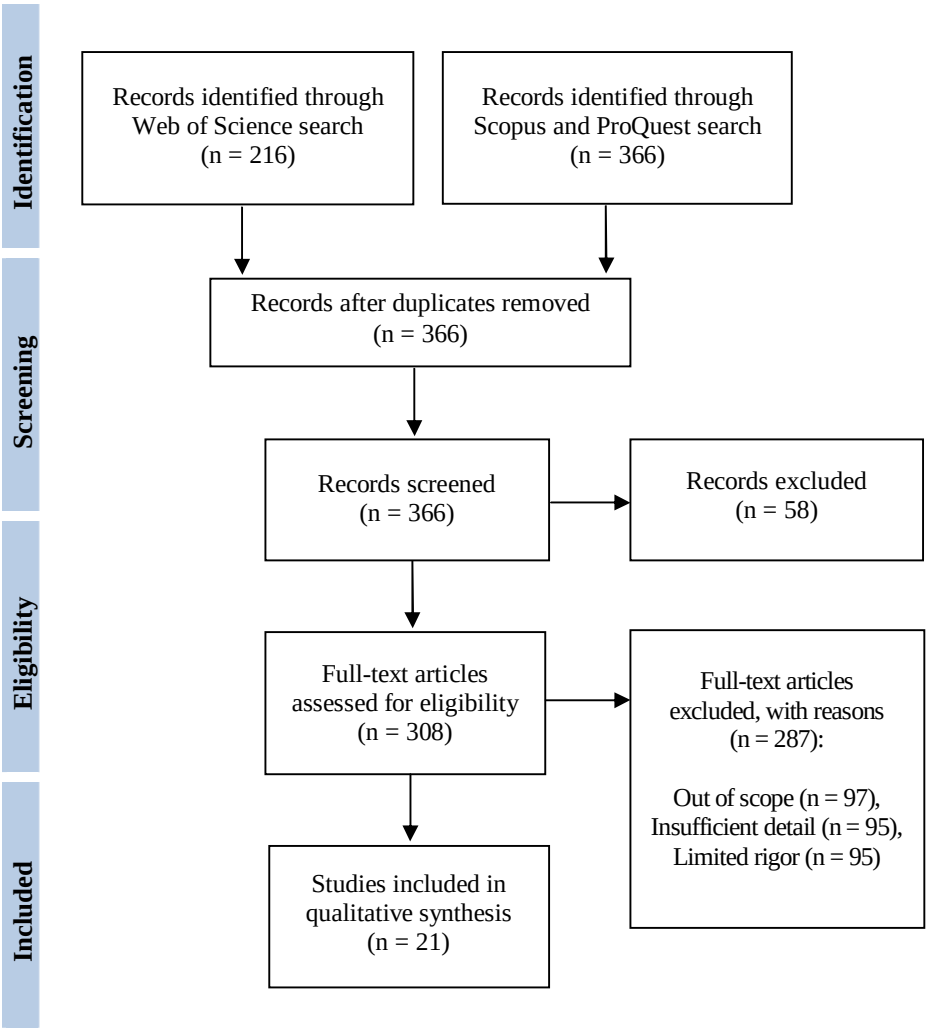


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

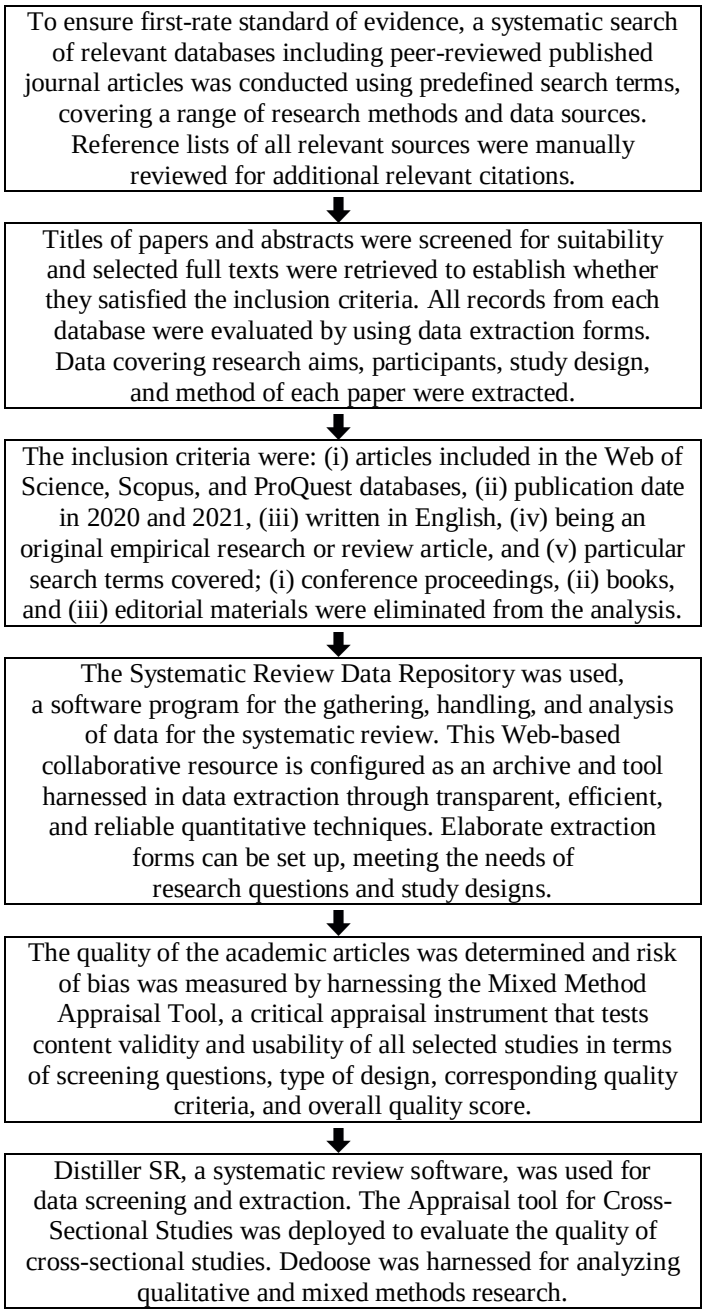


Figure 2 Screening and quality assessment tools

4. Psychological Well-Being, Intimate Relationships, and Sexual Behaviors during the COVID-19 Lockdown

Sexual activity affects psychological health, the immune response, and cognitive function positively (Jacob et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021), and can mitigate COVID-19-related psychosocial stressors. Interventions to further satisfactory mental and physical health throughout the COVID-19 self-isolation and physical distancing period should consider positive sexual health. During the COVID-19 outbreak, sexually active subjects display decreased anxiety and depressive symptoms. Lifestyle changes brought about by the COVID-19 crisis have negatively impacted the sexual functioning of persons and relationships.

The COVID-19 pandemic may intensify socioeconomic exclusion and diminish access to sexual health and reproductive services (Carvalho et al., 2021; Dema et al., 2022; Kumar et al., 2021; Wignall et al., 2021), configuring sociodemographic and behavioral risk determinants. Risky sexual behaviors (e.g., variable condom use and casual or multiple sexual partnerships) have considerably been decreased during the COVID-19 lockdown. COVID-19-related psychological adjustment, loneliness, and situational life stressors have influenced individuals' sexual health.

COVID-19 social restrictions have considerably disrupted sexual practices (Herbenick et al., 2022; Hille et al., 2021; Lehmiller et al., 2021; Tan et al., 2021) and the quality of sex lives. The reduction in partnered sexual activities has been aggravated for single individuals or for those that do not live with their partners. The COVID-19 outbreak has reconfigured time spent with romantic partners in addition to partnered sex, either as long-distance relationships or as increased physical closeness and intimacy, impacting psychological well-being, intimate relationships and sexual behaviors. For persons in relationships a diversification of the sexual repertoire has not taken place in couples having significant rates of relationship contentment and affection feelings/behavior during sexual activities. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Sexual activity affects psychological health, the immune response, and cognitive function positively, and can mitigate COVID-19-related psychosocial stressors.	Jacob et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
COVID-19-related psychological adjustment, loneliness, and situational life stressors have influenced individuals' sexual health.	Carvalho et al., 2021; Dema et al., 2022; Kumar et al., 2021; Wignall et al., 2021
COVID-19 social restrictions have considerably disrupted sexual practices and the quality of sex lives.	Herbenick et al., 2022; Hille et al., 2021; Lehmiller et al., 2021; Tan et al., 2021

5. COVID-19-related Sexual Functioning and Relationship Satisfaction

Measures to reduce the consequences of the COVID-19 pandemic may hinder the development of healthy sexual relationships (Karp et al., 2021; Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021), impacting partnership quality, relationship contentment, and sexual and reproductive health outcomes. Sexual activity, prevalence, and risky behaviors have deteriorated during the COVID-19 lockdown, resulting in significant psychorelational and sexual alterations in the affected individuals. Quarantine, physical distancing, social isolation, and home confinement-related stress and anxiety may increase sexual issues. Sexual desire changes can clarify why COVID-19-related lifestyle modifications are related to decreased relationship functioning.

The COVID-19 lockdown measures have influenced the incidence of diverse partnered and solitary sexual behaviors and activities (Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021), in addition to sexual functioning and relationship satisfaction concerning physical and mental well-being. Men and LGB individuals display more increases in diverse sexual behaviors in comparison with women and heterosexual people throughout the COVID-19 social lockdown. Relationship tension because of COVID-19 transmission and restrictions is consistently predictive of anxiety, depression, and loneliness.

Sexual function is affected by COVID-19-related mental health (Effati-Daryani et al., 2021; Feng et al., 2021; Hille et al., 2021; Omar et al., 2021; Szuster et al., 2021), thus impacting quality of life. The COVID-19 lockdown is related to an increased incidence of depressive symptoms and intensified risk of sexual dysfunction with reduced sexual desire and sexual frequency. For single persons, a modification of sexual practices has been configured by COVID-19 lockdown measures. Variable situations in sexual life and family function have impacted intimate relationships. Fear, unpredictability, and anxiety are associated with restrictions of individuals' activities in lockdown, with consequences to sexual satisfaction. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Measures to reduce the consequences of the COVID-19 pandemic may hinder the development of healthy sexual relationships.	Karp et al., 2021; Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
The COVID-19 lockdown measures have influenced the incidence of diverse partnered and solitary sexual behaviors and activities.	Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021
Sexual function is affected by COVID-19-related mental health, thus impacting quality of life.	Effati-Daryani et al., 2021; Feng et al., 2021; Hille et al., 2021; Omar et al., 2021; Szuster et al., 2021

6. Sexual Behavior and Satisfaction Due to COVID-19 Movement Control Measures

Sexual desire and sexual behaviors have been reconfigured during the COVID-19 social lockdown (Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Wignall et al., 2021) being associated with perceived health and subjective consequences on psychological wellbeing and being moderated in terms of gender and sexuality, in addition to romantic relationship status and non-restrictive opinions in relation to casual sex. Absence of sexual activity throughout the COVID-19 crisis is related to a considerably increased risk of developing anxiety and depression. Home confinement and physical distancing aggravate physical and sexual engagement, but couples can undertake creative manners of improving intimacy and eroticism, thus maintaining relational health.

COVID-19-related increased sexual desire, social isolation, and stress (Gleason et al., 2021; Lehmiller et al., 2021; Mollaioli et al., 2021) can result in intensified sexual variations to satisfy psychological needs or alleviate negative mood states. Sexual activity is protective to COVID-19 quarantine-related anxiety, depression, and relational issues. Depression symptoms are associated with declines in sexual enjoyment and casual sex, impacting sexual health due to incidence and satisfaction, i.e., resulting in detrimental sexual and reproductive health outcomes.

Modifications in sexual behavior and satisfaction due to COVID-19 movement control measures (Bowling et al., 2021; Hille et al., 2021; Rodrigues and Lehmiller, 2021; Tan et al., 2021) differ according to affected persons' partnership status and living arrangements. The COVID-19 outbreak has resulted in the perception of risky sexual behavior to be reconfigured and adjusted systematically. Alterations in sexual behavior as a result of external stressors (e.g., physical distancing measures) have impacted relationship satisfaction. Being compelled to adjust life routines and handle the COVID-19-related psychological distress has come into conflict both with sexual functioning and the intention to seek a romantic alliance with a person or to be favorably disposed to partnered sexual activity. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Sexual desire and sexual behaviors have been reconfigured during the COVID-19 social lockdown.	Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Wignall et al., 2021
Sexual activity is protective to COVID-19 quarantine-related anxiety, depression, and relational issues.	Gleason et al., 2021; Lehmiller et al., 2021; Mollaioli et al., 2021
Modifications in sexual behavior and satisfaction due to COVID-19 movement control measures differ according to affected persons' partnership status and living arrangements.	Bowling et al., 2021; Hille et al., 2021; Rodrigues and Lehmiller, 2021; Tan et al., 2021

7. Discussion

I integrate my systematic review throughout research indicating how lifestyle changes brought about by the COVID-19 crisis have negatively impacted the sexual functioning of persons and relationships. My research complements recent analyses clarifying how depression symptoms are associated with declines in sexual enjoyment and casual sex, impacting sexual health due to incidence and satisfaction. I elucidate, by cumulative evidence, previous research demonstrating how sexual function is affected by COVID-19-related mental health, thus impacting quality of life.

8. Synopsis of the Main Research Outcomes

COVID-19-related lifestyle modifications are related to decreased relationship functioning. Home confinement and physical distancing aggravate physical and sexual engagement. The COVID-19 lockdown is related to an increased incidence of depressive symptoms and intensified risk of sexual dysfunction. COVID-19 social restrictions have considerably disrupted sexual practices and the quality of sex lives. Variable situations in sexual life and family function have impacted intimate relationships.

9. Conclusions

Relevant research has investigated whether sexual desire and sexual behaviors have been reconfigured during the COVID-19 social lockdown. This systematic literature review presents the published peer-reviewed sources covering how modifications in sexual behavior and satisfaction due to COVID-19 movement control measures differ according to affected persons' partnership status and living arrangements. The research outcomes drawn from the above analyses indicate that the COVID-19 outbreak has impacted psychological well-being, intimate relationships and sexual behaviors.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2020 and 2021, relevant sources on COVID-19-related psychosocial stressors, sexual behaviors, and quality of life may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles) discounting others (conference proceedings articles, books, and editorial materials). The scope of my study also does not move forward the inspection of COVID-19-related sexual enjoyment and casual sex. Subsequent analyses should develop on sexual functioning and relationship satisfaction

concerning physical and mental well-being during the COVID-19 social lockdown. Future research should thus investigate COVID-19-related detrimental sexual and reproductive health outcomes. Attention should be directed to sexual frequency and relationship satisfaction throughout COVID-19 social restrictions.

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The Impact of COVID-19-related Stress, Anxiety, and Depression on Sexual Health

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ABSTRACT. The aim of this systematic review is to synthesize and analyze existing evidence on the impact of COVID-19-related stress, anxiety, and depression on sexual health. With increasing evidence of psychological distress as a result of COVID-19-related confinement, physical distancing, and social isolation, there is an essential demand for comprehending whether diminished incidence of social and sexual connections has resulted in unsatisfactory mental health outcomes. In this research, prior findings were cumulated indicating that COVID-19 lockdown measures have negatively affected sexual health and behaviors. I carried out a quantitative literature review of ProQuest, Scopus, and the Web of Science throughout June 2021, with search terms including "sexual activity + COVID-19," "sexual health + COVID-19," "sexual behavior + COVID-19," "sexual life + COVID-19," and "sexual desire + COVID-19." As I analyzed research published between 2020 and 2021, only 379 papers met the eligibility criteria. By removing controversial or unclear findings (scanty/unimportant data), results unsupported by replication, undetailed content, or papers having quite similar titles, I decided on 22, chiefly empirical, sources. Subsequent analyses should develop on intimate relationships, family functions, and sexual behavior of partners during the COVID-19 pandemic. Future research should thus investigate how COVID-19-related confinement, physical distancing, and social isolation have impacted sexual health. Attention should be directed to sexual health and behaviors associated with COVID-19 lockdown measures.

Keywords: COVID-19; stress; anxiety; depression; sexual; health

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on the impact of COVID-19-related stress, anxiety, and depression on sexual health and integrate the insights it configures on sexual frequency and relationship satisfaction during the COVID-19 lockdown. By analyzing the most recent (2020–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that assessing sexual health configures psychological distress as a result of COVID-19-related confinement, physical distancing, and social isolation. The actuality and novelty of this study are articulated by addressing how sexual functioning has been considerably affected by COVID-19-related stress, anxiety, and depression (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021; Morrison and Lăzăroiu, 2021), that is an emerging topic involving much interest. My research problem is whether diminished incidence of social and sexual connections has resulted in unsatisfactory mental health outcomes.

In this review, prior findings have been cumulated indicating that COVID-19 lockdown measures have negatively affected sexual health and behaviors. The identified gaps advance how the COVID-19 lockdown measures have negatively influenced the sexual routines and sexual health of affected persons. My main objective is to indicate that frequency of sexual behavior has significantly decreased during COVID-19 large-scale restrictions. This systematic review contributes to the literature on the impact of COVID-19-related stress, anxiety, and depression on sexual health by clarifying that the COVID-19 outbreak has been related to an increased incidence of depressive symptoms, lifestyle alteration, and sexual functioning disorders. This research endeavors to elucidate whether consequences of isolation and deterioration in social and physical contacts have impacted sexual and mental health. My contribution is by integrating research findings indicating that COVID-19 physical distancing and stay-at-home measures have impacted sexual relations.

2. Theoretical Overview of the Main Concepts

Romantic and sexual lives have been thoroughly disrupted throughout the COVID-19 crisis. COVID-19 lockdown has thoroughly affected the psychological, relational, and sexual health of individuals. Sexual frequency and relationship satisfaction have been impacted due to COVID-19 lockdown and physical distancing measures. Individuals who have managed constant in-person social and sexual connections have had satisfactory mental health outcomes. Bringing about physical, emotional, and psychological harm, the COVID-19 outbreak may impact individuals' sexual and reproductive

health. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), sexual frequency and relationship satisfaction during the COVID-19 lockdown (section 4), COVID-19 sexual functioning, behavior, and activities (section 5), sexual health and psychological well-being due to the COVID-19 outbreak (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout June 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "sexual activity + COVID-19," "sexual health + COVID-19," "sexual behavior + COVID-19," "sexual life + COVID-19," and "sexual desire + COVID-19." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2020 and 2021 was analyzed, only 379 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 22, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Sexual activity + COVID-19	96	4
Sexual health + COVID-19	98	6
Sexual behavior + COVID-19	93	5
Sexual life + COVID-19	59	4
Sexual desire + COVID-19	33	3
Type of paper		
Original research	293	21
Review	36	1
Conference proceedings	24	0
Book	7	0
Editorial	19	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Assessing sexual health configures psychological distress as a result of COVID-19-related confinement, physical distancing, and social isolation.	Jacob et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
Sexual frequency and relationship satisfaction have been impacted due to COVID-19 lockdown and physical distancing measures. Individuals who have managed constant in-person social and sexual connections have had satisfactory mental health outcomes.	Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021
COVID-19 lockdown measures have negatively affected sexual health and behaviors. Romantic and sexual lives have been thoroughly disrupted throughout the COVID-19 crisis.	Feng et al., 2021; Herbenick et al., 2022; Pascoal et al., 2021; Reyniers et al., 2021
COVID-19 quarantine has generated a significant instability in terms of psychological, relational, and sexual functioning.	Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021
Diminished incidence of social and sexual connections has resulted in unsatisfactory mental health outcomes. Increased anxiety and depression predict reduced sexual enjoyment and casual partner prevalence.	Gleason et al., 2021; Rodrigues and Lehmiller, 2021; Rosenberg et al., 2021; Wignall et al., 2021
Sexual functioning has been considerably affected by COVID-19-related stress, anxiety, and depression. The COVID-19 outbreak has been related to an increased incidence of depressive symptoms, lifestyle alteration, and sexual functioning disorders.	Effati-Daryani et al., 2021; Feng et al., 2021; Hille et al., 2021; Szuster et al., 2021
The COVID-19 lockdown measures have negatively influenced the sexual routines and sexual health of affected persons. Bringing about physical, emotional, and psychological harm, the COVID-19 outbreak may impact individuals' sexual and reproductive health.	Coombe et al., 2021; Mollaioli et al., 2021; Rodrigues and Lehmiller, 2021; Tu et al., 2021
Frequency of sexual behavior has significantly decreased during COVID-19 large-scale restrictions.	Jenness et al., 2021; Kumar et al., 2021; Lehmiller et al., 2021
Single individuals or not living with their partners have confronted a significant reduction in sexual activities with constant and casual partners, and a considerable intensification in solitary sexual behaviors.	Bowling et al., 2021; Hille et al., 2021; Tan et al., 2021

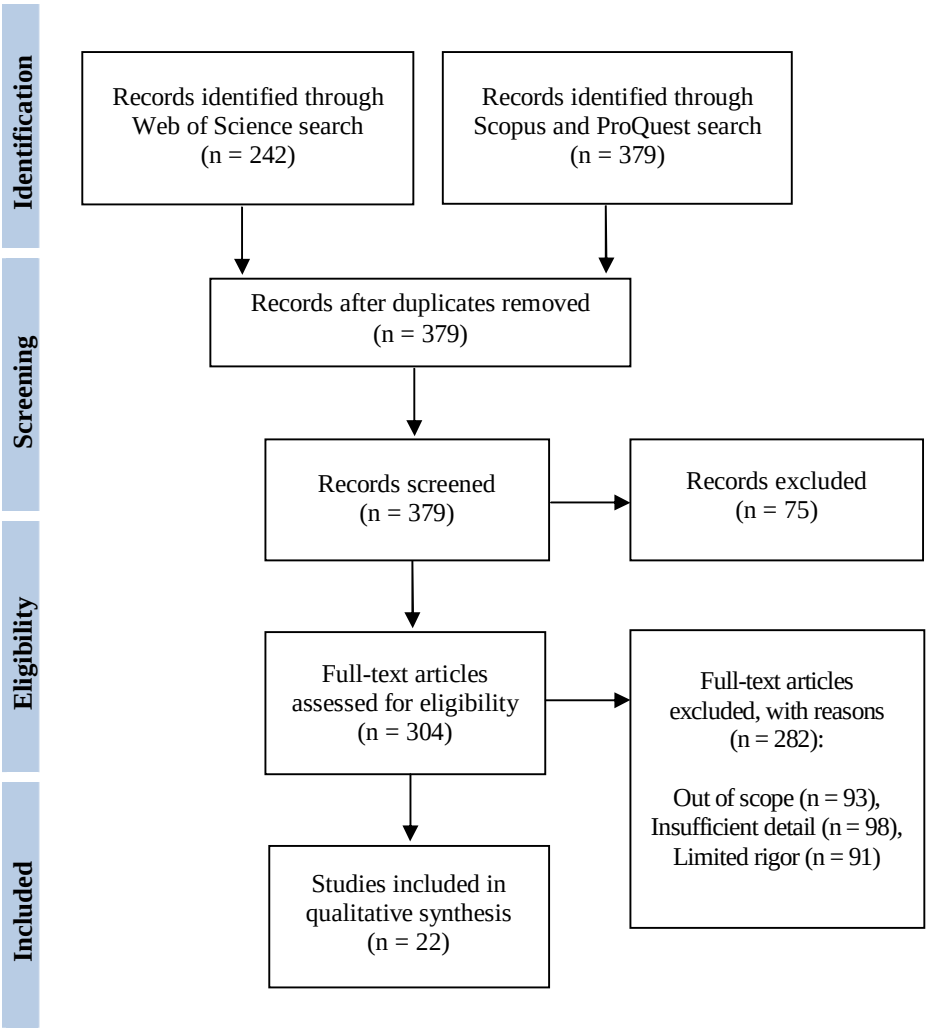


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

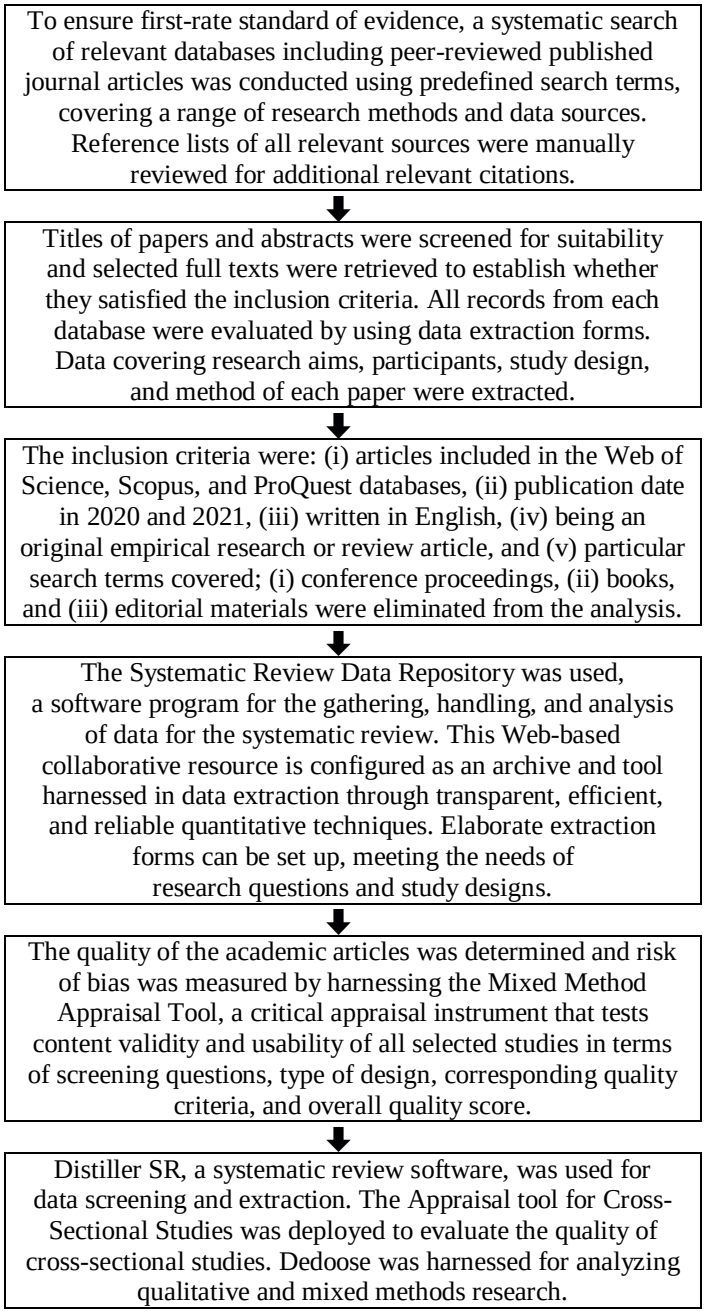


Figure 2 Screening and quality assessment tools

4. Sexual Frequency and Relationship Satisfaction during the COVID-19 Lockdown

Interventions to further sexual activity throughout the COVID-19 outbreak (Jacob et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021) may mitigate adverse health effects associated with self-isolation and should focus on individuals having unsatisfactory sexual activity. Assessing sexual health configures psychological distress as a result of COVID-19-related confinement, physical distancing, and social isolation. Continuing sexual activity during the COVID-19 pandemic can optimize cognitive, immunity, and cardiovascular function. As stress-provoking contexts can make deadliness more pronounced and intensify sexual desire, lifestyle alterations and fear of contracting COVID-19 may have helped the consolidation of certain relationships.

Sexual frequency and relationship satisfaction (Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021) have been impacted due to COVID-19 lockdown and physical distancing measures. Sexual desire and sociosexuality may impact general health and subjective wellbeing during the COVID-19 lockdown on. Depression and loneliness have escalated throughout the COVID-19 outbreak: individuals who have managed constant in-person social and sexual connections have had satisfactory mental health outcomes.

Romantic and sexual lives have been thoroughly disrupted throughout the COVID-19 crisis (Feng et al., 2021; Herbenick et al., 2022; Pascoal et al., 2021; Reyniers et al., 2021) in terms of proximity to partners, in addition to related instability. COVID-19 lockdown measures have negatively affected sexual health and behaviors. Physical distancing and stay-at-home measures have impacted sexual relations and incidence of physical sex between individuals who do not live together. Intimate relationships, family functions, and sexual behavior of partners have gone through significant changes. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Assessing sexual health configures psychological distress as a result of COVID-19-related confinement, physical distancing, and social isolation.	Jacob et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021; Rodrigues and Lehmiller, 2021
Sexual frequency and relationship satisfaction have been impacted due to COVID-19 lockdown and physical distancing measures.	Gleason et al., 2021; Rosenberg et al., 2021; Wignall et al., 2021
COVID-19 lockdown measures have negatively affected sexual health and behaviors.	Feng et al., 2021; Herbenick et al., 2022; Pascoal et al., 2021; Reyniers et al., 2021

5. COVID-19 Sexual Functioning, Behavior, and Activities

As a result of the COVID-19 containment measures, individuals have experienced a reduction in sexual desire and in sexual intercourse incidence (Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021), an intensification of solitary sexual behavior, a decline in alcohol consumption associated with sexual activities, and a worsening of partner relationships. COVID-19 quarantine has generated a significant instability in terms of psychological, relational, and sexual functioning. Sexual activity between cohabiting partners has beneficial consequences on the mental state, cognitive outcome, and immunity of affected individuals.

Diminished incidence of social and sexual connections (Gleason et al., 2021; Rodrigues and Lehmiller, 2021; Rosenberg et al., 2021; Wignall et al., 2021) has resulted in unsatisfactory mental health outcomes. Persons in relationships have experienced intensification of diverse sexual behaviors throughout the COVID-19 social lockdown in contrast to individuals who are single or date casually. Increased anxiety and depression predict reduced sexual enjoyment and casual partner prevalence. Persons experiencing systematic lifestyle changes undergo elevated sexual desire and thus positive relationship functioning due to perception of COVID-19 fear.

Sexual functioning has been considerably affected (Effati-Daryani et al., 2021; Feng et al., 2021; Hille et al., 2021; Szuster et al., 2021) by COVID-19-related stress, anxiety, and depression. The COVID-19 outbreak has been related to an increased incidence of depressive symptoms, lifestyle alteration, and sexual functioning disorders. Consequences of isolation and deterioration in social and physical contacts have impacted sexual and mental health. Sexual behavior changes, in terms of satisfaction and quality, and family function have been adversely related to intimacy. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

COVID-19 quarantine has generated a significant instability in terms of psychological, relational, and sexual functioning.	Li et al., 2020; Mollaioli et al., 2021; Pennanen-Iire et al., 2021
Diminished incidence of social and sexual connections has resulted in unsatisfactory mental health outcomes.	Gleason et al., 2021; Rodrigues and Lehmiller, 2021; Rosenberg et al., 2021; Wignall et al., 2021
Sexual functioning has been considerably affected by COVID-19-related stress, anxiety, and depression. The COVID-19 outbreak has been related to an increased incidence of depressive symptoms, lifestyle alteration, and sexual functioning disorders.	Effati-Daryani et al., 2021; Feng et al., 2021; Hille et al., 2021; Szuster et al., 2021

6. Sexual Health and Psychological Well-Being Due to the COVID-19 Outbreak

The COVID-19 lockdown measures have negatively influenced the sexual routines and sexual health of affected persons (Coombe et al., 2021; Mollaioli et al., 2021; Rodrigues and Lehmiller, 2021; Tu et al., 2021), resulting in an increase in solitary sex activities. COVID-19 lockdown has thoroughly affected the psychological, relational, and sexual health of individuals. Bringing about physical, emotional, and psychological harm, the COVID-19 outbreak may impact individuals' sexual and reproductive health. Lifestyle changes have been related to heightened sexual desire among persons fearful of contracting COVID-19 and who have experienced increased positive modifications in their sex lives and wished to spend time with their partners, but not to increased relationship quality.

The COVID-19 outbreak has exposed and intensified prevalent socio-economic and health incongruities (Jenness et al., 2021; Kumar et al., 2021; Lehmiller et al., 2021) in terms of sexual health and psychological well-being. The COVID-19 crisis may have resulted in an increase in transmission dynamics and prevention sexually transmitted infections. Frequency of sexual behavior has significantly decreased during COVID-19 large-scale restrictions on mobility and social contact.

Lacking reliable and extensive messaging in handling compatible perceptions and the factualities of sexual risk as regards COVID-19 (Bowling et al., 2021; Hille et al., 2021; Tan et al., 2021), affected persons may be despondent of how to optimize their safety. Single individuals or not living with their partners have confronted a significant reduction in sexual activities with constant and casual partners, and a considerable intensification in solitary sexual behaviors. The assimilation of complementary sexual routines by couples has been associated with sociosexual features and physical sexual attraction. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

The COVID-19 lockdown measures have negatively influenced the sexual routines and sexual health of affected persons.	Coombe et al., 2021; Mollaioli et al., 2021; Rodrigues and Lehmiller, 2021; Tu et al., 2021
Frequency of sexual behavior has significantly decreased during COVID-19 large-scale restrictions.	Jenness et al., 2021; Kumar et al., 2021; Lehmiller et al., 2021
Single individuals or not living with their partners have confronted a significant reduction in sexual activities with constant and casual partners, and a considerable intensification in solitary sexual behaviors.	Bowling et al., 2021; Hille et al., 2021; Tan et al., 2021

7. Discussion

I integrate our systematic review throughout research indicating how assessing sexual health configures psychological distress as a result of COVID-19-related confinement, physical distancing, and social isolation. My research complements recent analyses clarifying how frequency of sexual behavior has significantly decreased during COVID-19 large-scale restrictions. I elucidate, by cumulative evidence, previous research demonstrating how consequences of isolation and deterioration in social and physical contacts have impacted sexual and mental health.

8. Synopsis of the Main Research Outcomes

Diminished incidence of social and sexual connections has resulted in unsatisfactory mental health outcomes. COVID-19 physical distancing and stay-at-home measures have impacted sexual relations. Sexual frequency and relationship satisfaction have been impacted due to COVID-19 lockdown and physical distancing measures. Romantic and sexual lives have been thoroughly disrupted throughout the COVID-19 crisis. Bringing about physical, emotional, and psychological harm, the COVID-19 outbreak may impact individuals' sexual and reproductive health.

9. Conclusions

Relevant research has investigated whether sexual functioning has been considerably affected by COVID-19-related stress, anxiety, and depression. This systematic literature review presents the published peer-reviewed sources covering the COVID-19 outbreak has been related to an increased incidence of depressive symptoms, lifestyle alteration, and sexual functioning disorders. The research outcomes drawn from the above analyses indicate that COVID-19 lockdown measures have negatively affected sexual health and behaviors.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2018 and 2021, relevant sources on the impact of COVID-19-related stress, anxiety, and depression on sexual health may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles) discounting others (conference proceedings articles, books, and editorial materials). The scope of my study also does not move forward the inspection of COVID-19-related prevalent socio-economic and health incongruities in terms of sexual health and psychological well-being. Sub-

sequent analyses should develop on Intimate relationships, family functions, and sexual behavior of partners during the COVID-19 pandemic. Future research should thus investigate how COVID-19-related confinement, physical distancing, and social isolation have impacted sexual health. In the future, attention should be directed to sexual health and behaviors associated with COVID-19 lockdown measures.

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Compliance with ethical standards
This article does not contain any studies with human participants or animals performed by the author.

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All data generated or analyzed are included in the published article.

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The author confirms being the sole contributor of this work and approved it for publication. The author takes full responsibility for the accuracy and the integrity of the data analysis.

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Technologically-mediated Emotional and Social Experiences: Intimate Data Sharing by Algorithm-based Fertility Apps

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ABSTRACT. The purpose of this study is to examine technologically-mediated emotional and social experiences as intimate data sharing by algorithm-based fertility apps. In this article, I cumulate previous research findings indicating that deploying period start dates, algorithm-based fertility apps assess a user's daily pregnancy risk and determine her distinctive fertile window. I contribute to the literature on smartphone apps for tracking physiological signs of ovulation by showing that fertility apps constitute a digital tool for tracking menstruation and physiological signs of ovulation, generating increased and detailed information as regards the user's menstrual cycle and predictions in relation to the most fertile days/window in the cycle. Throughout May 2021, I performed a quantitative literature review of the Web of Science, Scopus, and ProQuest databases, with search terms including "fertility tracking apps," "menstrual cycle tracking apps," "female reproductive health apps," and "period and fertility tracking apps." As I inspected research published in 2019 and 2021, only 177 articles satisfied the eligibility criteria. By eliminating controversial findings, outcomes unsubstantiated by replication, too imprecise material, or having similar titles, I decided upon 21, generally empirical, sources. Subsequent analyses should develop on intimate data sharing through big data-driven apps and algorithms. Future research should thus investigate handling biometric data as regards menstruation. Attention should be directed to precision of fertility data within menstrual cycle tracking apps.

Keywords: intimate; data; sharing; algorithm; fertility; app

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on technologically-mediated emotional and social experiences as intimate data sharing by algorithm-based fertility apps and integrate the insights it configures on smartphone apps for tracking physiological signs of ovulation. By analyzing the most recent (2019–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that menstrual cycle tracking apps require accuracy in ascertaining ovulation and practicality in furthering and preventing pregnancy. The actuality and novelty of this study are articulated by addressing the relationship between female reproductive health, period and fertility tracking apps, and machine learning algorithms, that is an emerging topic involving much interest. My research problem is whether period trackers are cutting-edge smartphone apps in cycle monitoring, assisting women in handling their reproductive health in terms of periods, fertility, prenatal period, childbearing, and menopause.

In this review, prior findings have been cumulated indicating that deploying period start dates, algorithm-based fertility apps assess a user's daily pregnancy risk and determine her distinctive fertile window. The identified gaps advance how female reproductive health apps analyze the data of users' menstrual cycle and the intimately linked hormones. My main objective is to indicate that fertility apps constitute a digital tool for tracking menstruation and physiological signs of ovulation, generating increased and detailed information as regards the user's menstrual cycle and predictions in relation to the most fertile days/window in the cycle. This systematic review contributes to the literature on emotional and social experiences as intimate data sharing by algorithm-based fertility apps (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021; Morrison and Lăzăroiu, 2021) by clarifying that smartphone apps for tracking physiological signs of ovulation are algorithmic tools for enabling or preventing pregnancy.

This research endeavors to elucidate whether the use of mobile apps that examine fertility signs is adopted by sexually active women who track their fertility window. My contribution is by integrating research findings indicating that menstrual cycle tracking apps provide users with their predicted ovulation and ideal period to attempt to conceive.

2. Theoretical Overview of the Main Concepts

Menstrual tracking and prediction are essential to ordinary leverage of fertility-based apps and data are harnessed to monitor the user's general health by exhibiting patterns and identifying disorderings in standard cycle rhythms. Users should monitor and gain from the data collected by digital

apps for tracking menstruation. Technology-driven fertility awareness-based methods harness machine learning algorithms to determine fertile days according to diverse methods to integrating women's menstrual cycle records and bodily biomarkers. Precision of fertility data within menstrual cycle tracking apps is instrumental for female reproductive health. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), smartphone apps for tracking physiological signs of ovulation (section 4), female reproductive health, period and fertility tracking apps, and machine learning algorithms (section 5), biometric data and fertility tracking apps (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "fertility tracking apps," "menstrual cycle tracking apps," "female reproductive health apps," and "period and fertility tracking apps." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2019 and 2021 was analyzed, only 177 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 21, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Fertility tracking apps	67	8
Menstrual cycle tracking apps	44	5
Female reproductive health apps	37	4
Period and fertility tracking apps	29	4
Type of paper		
Original research	106	19
Review	27	2
Conference proceedings	21	0
Book	6	0
Editorial	17	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Fertility tracking apps harness menstrual cycle duration to algorithmically establish the fertile window. Deploying period start dates, algorithm-based fertility apps assess a user's daily pregnancy risk and deter- mine her distinctive fertile window.	Healy, 2021; Jennings et al., 2019a; Kressbach, 2021; Simmons and Jennings, 2020
Technology-driven fertility awareness-based methods harness machine learning algorithms to determine fertile days by integrating women's menstrual cycle records and bodily biomarkers.	Ali et al., 2021; Jennings et al., 2019b; Kressbach, 2021; Schantz et al., 2021
Smartphone apps for tracking physiological signs of ovulation are algorithmic tools for enabling or preventing pregnancy. Menstrual tracking and prediction are essential to ordinary leverage of fertility-based apps.	Hamper, 2021; Kressbach, 2021; Pichon et al., 2021
Female reproductive health apps analyze the data of users' menstrual cycle and the intimately linked hormones.	Ford et al., 2021a; Bull et al., 2019; Kressbach, 2021; Pichon et al., 2021
Fertility apps constitute a digital tool for tracking menstruation and physiological signs of ovulation, generating increased and detailed information. The integration of basal body temperature and the deployment of a fertility tracking app may assist in identifying testing days.	Bull et al., 2019; Hamper, 2020; Hohmann-Marriott, 2021; Kressbach, 2021
Precision of fertility data within menstrual cycle tracking apps is instrumental for female reproductive health. Fertility tracking mobile apps are designed to reinforce the specific knowledge and emotional needs and ordinary experiences of users.	Figueiredo et al., 2021; Ford et al., 2021b; Gilman, 2021; Kressbach, 2021
Period trackers assist women in handling their reproductive health in terms of periods, fertility, prenatal period, childbearing, and menopause. Users' objectives for comprehending their symptoms and emotional states are not specifically well-supported by menstrual cycle tracking apps.	Figueiredo et al., 2021; Gilman, 2021; Kressbach, 2021
The use of mobile apps that examine fertility signs is adopted by sexually active women who track their fertility window. Fertility tracking apps generally employ menstrual cycle dates to assess ovulation or assimilate biometrics into the fertile window calculation.	Al-Rshoud et al., 2021; Favaro et al., 2021; Hamper, 2020
Menstrual cycle tracking apps provide users with their predicted ovulation and ideal period to attempt to conceive. Fertility tracking apps require basal body temperature and ovulation data to optimize their predictive ability.	Blair et al., 2021; Ford et al., 2021a; Grieger and Norman, 2020; Kressbach, 2021

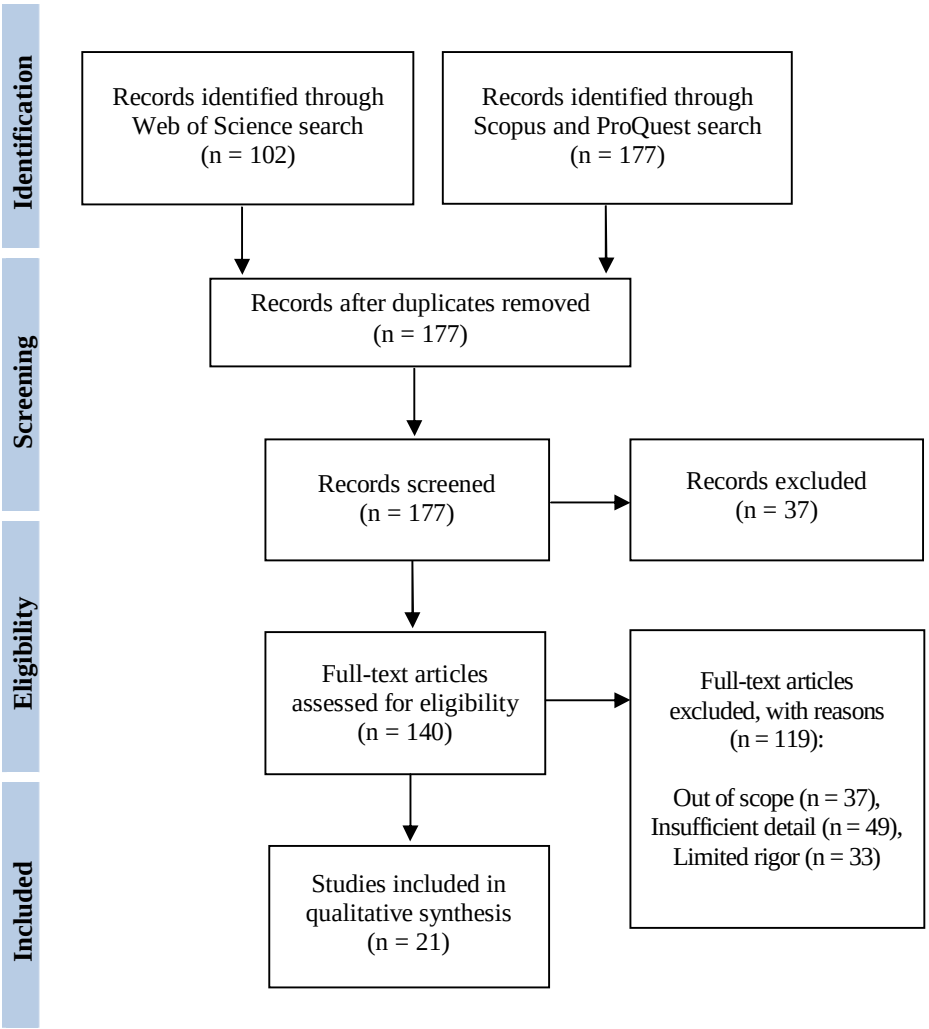


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

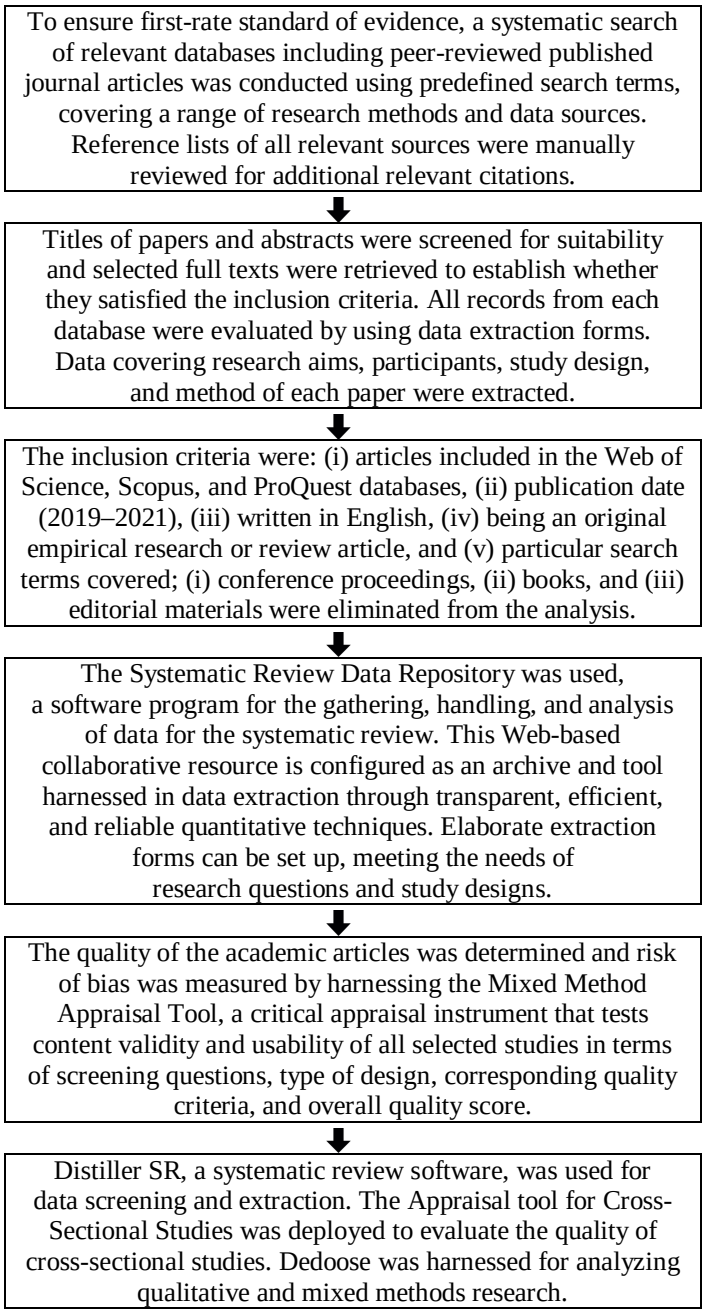


Figure 2 Screening and quality assessment tools

4. Smartphone Apps for Tracking Physiological Signs of Ovulation

Fertility tracking apps harness menstrual cycle duration (Healy, 2021; Jennings et al., 2019a; Kressbach, 2021; Simmons and Jennings, 2020) to algorithmically establish the fertile window. Big data-driven apps and algorithms are fashioned to construct certain variants of reproductive femininity by use of intimate data sharing. By conferring elucidative capacity to biological operations that are out of the user's monitoring, fertility tracker apps conceive the body as a disorderly and unmanageable source of heterogeneous intricate emotional and physical experiences. Deploying period start dates, algorithm-based fertility apps assess a user's daily pregnancy risk and determine her distinctive fertile window.

Technology-driven fertility awareness-based methods harness machine learning algorithms (Ali et al., 2021; Jennings et al., 2019b; Kressbach, 2021; Schantz et al., 2021) to determine fertile days according to diverse methods by integrating women's menstrual cycle records and bodily biomarkers. Imprecise calendar apps provide women with erroneous information as regards their fertile window. Operating as a manner to check physical and emotional alterations, and by identifying patterns, the logs may enable users of fertility-based apps to more thoroughly keep secret indications of their menstrual status. Menstrual cycle tracking apps require accuracy in ascertaining ovulation and practicality in furthering and preventing pregnancy.

Smartphone apps for tracking physiological signs of ovulation (Hamper, 2021; Kressbach, 2021; Pichon et al., 2021) are algorithmic tools for enabling or preventing pregnancy. Menstrual tracking and prediction are essential to ordinary leverage of fertility-based apps and data are harnessed to monitor the user's general health by exhibiting patterns and identifying disorderings in standard cycle rhythms. Fertility tracking mobile apps conjecture that each woman's fertile interval has the same length. (Johnson et al., 2020) Menstrual tracking apps users are interpreted as undistinguishable, as a result of pernicious, restrictive stereotypes. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Fertility tracking apps harness menstrual cycle duration to algorithmically establish the fertile window.	Healy, 2021; Jennings et al., 2019a; Kressbach, 2021; Simmons and Jennings, 2020
Technology-driven fertility awareness-based methods harness machine learning algorithms to determine fertile days by integrating women's menstrual cycle records and bodily biomarkers.	Ali et al., 2021; Jennings et al., 2019b; Kressbach, 2021; Schantz et al., 2021
Smartphone apps for tracking physiological signs of ovulation are algorithmic tools for enabling or preventing pregnancy.	Hamper, 2021; Kressbach, 2021; Pichon et al., 2021

5. Female Reproductive Health, Period and Fertility Tracking Apps, and Machine Learning Algorithms

Female reproductive health apps analyze the data of users' menstrual cycle (Ford et al., 2021a; Bull et al., 2019; Kressbach, 2021; Pichon et al., 2021) and the intimately linked hormones. The analytic contents of the fertility smartphone apps provide statistical data as regards cycles and timeline characteristics meant to display patterns and interrelationships. Menstrual cycle tracking apps that deploy basal body temperature and additional physiological parameters to determine ovulation day and luteal phase interval can clarify distinct fertility and bolster preliminary identification of subfertility. App- or tech-based fertility trackers generally aim to support women having irregular cycles by enabling them to configure menstrual cycle length through machine learning algorithms.

Fertility apps constitute a digital tool for tracking menstruation and physiological signs of ovulation (Bull et al., 2019; Hamper, 2020; Hohmann-Marriott, 2021; Kressbach, 2021), generating increased and detailed information as regards the user's menstrual cycle and predictions in relation to the most fertile days/window in the cycle. The big data-driven representation of self-examination provided by period and fertility tracking apps may articulate a biologically deterministic grasp of the personality and biomedical physiological alienation. The integration of basal body temperature and the deployment of a fertility tracking app may assist in identifying testing days. Users should monitor and gain from the data collected by digital apps for tracking menstruation.

Precision of fertility data within menstrual cycle tracking apps (Figueiredo et al., 2021; Ford et al., 2021b; Gilman, 2021; Kressbach, 2021) is instrumental for female reproductive health. Menstrual tracking and fertility apps consolidate approaches as regards menstrual concealment and physiological alienation. Users lose control over how their personal data is employed. Fertility tracking mobile apps are designed to reinforce the specific knowledge and emotional needs and ordinary experiences of users. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Female reproductive health apps analyze the data of users' menstrual cycle and the intimately linked hormones.	Ford et al., 2021a; Bull et al., 2019; Kressbach, 2021; Pichon et al., 2021
Fertility apps constitute a digital tool for tracking menstruation and physiological signs of ovulation, generating increased and detailed information.	Bull et al., 2019; Hamper, 2020; Hohmann-Marriott, 2021; Kressbach, 2021
Precision of fertility data within menstrual cycle tracking apps is instrumental for female reproductive health.	Figueiredo et al., 2021; Ford et al., 2021b; Gilman, 2021; Kressbach, 2021

6. Biometric Data and Fertility Tracking Apps

Period trackers are cutting-edge smartphone apps in cycle monitoring (Figueiredo et al., 2021; Gilman, 2021; Kressbach, 2021), assisting women in handling their reproductive health in terms of periods, fertility, prenatal period, childbearing, and menopause, while preventing them from having personal data control, producing discriminatory data, being deficient in up-to-standard data security, being woefully imprecise, putting into operation a damaging gender binary, and discrediting menstruation. Users' objectives for comprehending their symptoms and emotional states are not specifically well-supported by menstrual cycle tracking apps. Period and fertility tracking apps and the intrinsic big data approaches are ideological devices for biomedical physiological alienation and menstrual concealment.

The use of mobile apps that examine fertility signs (Al-Rshoud et al., 2021; Favaro et al., 2021; Hamper, 2020) is adopted by sexually active women who track their fertility window. Menstrual cycle tracking apps are integrated across women's variable types of manifestation and their routines of fertility tracking are strengthened by distinct justifications that highlight the links between knowledge, empowerment, and monitoring. Fertility tracking apps generally employ menstrual cycle dates to assess ovulation or assimilate biometrics (e.g., basal body temperature and luteinizing hormone) into the fertile window calculation.

Users' routines of handling biometric data as regards their menstruation (Blair et al., 2021; Ford et al., 2021a; Grieger and Norman, 2020; Kressbach, 2021) configure connections to their bodies and hormonal cycles, articulating technologically-mediated emotional and social experiences. The self-tracking and data analytic characteristics underpin approaches covering menstrual concealment and biomedical physiological alienation. Menstrual cycle tracking apps provide users with their predicted ovulation and ideal period to attempt to conceive, but not with conception chances. Fertility tracking apps require basal body temperature and ovulation data to optimize their predictive ability. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Period trackers assist women in handling their reproductive health in terms of periods, fertility, prenatal period, childbearing, and menopause.	Figueiredo et al., 2021; Gilman, 2021; Kressbach, 2021
The use of mobile apps that examine fertility signs is adopted by sexually active women who track their fertility window.	Al-Rshoud et al., 2021; Favaro et al., 2021; Hamper, 2020
Menstrual cycle tracking apps provide users with their predicted ovulation and ideal period to attempt to conceive.	Blair et al., 2021; Ford et al., 2021a; Grieger and Norman, 2020; Kressbach, 2021

7. Discussion

I integrate our systematic review throughout research indicating how fertility tracking apps harness menstrual cycle duration to algorithmically establish the fertile window. My research complements recent analyses clarifying how menstrual cycle tracking apps are integrated across women's variable types of manifestation. I elucidate, by cumulative evidence, previous research demonstrating how the integration of basal body temperature and the deployment of a fertility tracking app may assist in identifying testing days.

8. Synopsis of the Main Research Outcomes

The analytic contents of the fertility smartphone apps provide statistical data as regards cycles and timeline characteristics meant to display patterns and interrelationships. Fertility tracking apps require basal body temperature and ovulation data to optimize their predictive ability configuring the big data-driven representation of self-examination provided by period and fertility tracking apps. Imprecise calendar apps provide women with erroneous information as regards their fertile window.

9. Conclusions

Relevant research has investigated whether big data-driven apps and algorithms are fashioned to construct certain variants of reproductive femininity by use of intimate data sharing. This systematic literature review presents the published peer-reviewed sources covering how fertility tracking apps generally employ menstrual cycle dates to assess ovulation or assimilate biometrics into the fertile window calculation. The research outcomes drawn from the above analyses indicate that users' routines of handling biometric data as regards their menstruation configure connections to their bodies and hormonal cycles.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2019 and 2021, relevant sources on technologically-mediated emotional and social experiences as intimate data sharing by algorithm-based fertility apps may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles) discounting others (conference proceedings articles, books, and editorial materials). The scope of my study also does not move forward the inspection of how symptoms and emotional states are supported by menstrual cycle tracking apps. Subsequent

analyses should develop on intimate data sharing through big data-driven apps and algorithms. Future research should thus investigate handling biometric data as regards menstruation. Attention should be directed to precision of fertility data within menstrual cycle tracking apps.


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Transparency statement
The author affirms that the manuscript represents an honest, accurate, and transparent account of the research being reported, that no relevant aspects of the study have been left out, and that any inconsistencies from the research as planned (and, if significant, registered) have been clarified.

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Digital Semantics of Beauty Apps and Filters: Big Data-driven Facial Retouching, Aesthetic Self-Monitoring Devices, and Augmented Reality-based Body-Enhancing Technologies

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ABSTRACT. Based on an in-depth survey of the literature, the purpose of the paper is to explore digital semantics of beauty apps and filters. With growing evidence of big data-driven facial retouching, aesthetic self-monitoring devices, and augmented reality-based body-enhancing technologies, there is a pivotal need for comprehending the relationship between machine-driven facial retouching, digital filter-based beauty apps, and image datafication. In this research, previous findings were cumulated showing that photo editing apps constitute a risk determinant for users' body image concerns, and contribute to the literature by indicating that aesthetic comparing apps algorithmically appraise face and body perception. Throughout April 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was performed, with search terms including "beauty apps," "face filter apps," "beauty filter apps," and "facial editing apps." As research published between 2017 and 2021 was inspected, only 144 articles satisfied the eligibility criteria. By taking out controversial or ambiguous findings (insufficient/irrelevant data), outcomes unsubstantiated by replication, too general material, or studies with nearly identical titles, we selected 20 mainly empirical sources. Subsequent analyses should develop on body-enhancing technologies and face-filters that harness augmented reality. Future research should thus investigate snapchat and selfie dysmorphia. Attention should be directed to how filtered selfies have led to an interest in facial plastic surgery.

Keywords: beauty; app; filter; augmented reality; facial retouching; big data

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1. Introduction

The purpose of our systematic review is to examine the recently published literature on digital semantics of beauty apps and filters and integrate the insights it configures on big data-driven facial retouching, aesthetic self-monitoring devices, and augmented reality-based body-enhancing technologies. By analyzing the most recent (2017–2021) and significant (Web of Science, Scopus, and ProQuest) sources, our paper has attempted to prove that digital filter-based beauty apps articulate a technology of confidence-building buckling down to female users' anxiety as regards their physical appearance. The actuality and novelty of this study are articulated by addressing the relationship between machine-driven facial retouching, digital filter-based beauty apps, and image datafication, that is an emerging topic involving much interest. Our research problem is whether beauty apps provide guidance as regards optimizing physical appearance.

In this review, prior findings have been cumulated indicating that the variable alteration in perceived facial attractiveness is contingent upon the degree of beauty retouching. The identified gaps advance the relationship between augmented reality beauty apps, facial retouching behaviors, and body-enhancing technologies. Our main objective is to indicate that photo editing apps constitute a risk determinant for users' body image concerns. This systematic review contributes to the literature on digital semantics of beauty apps and filters by clarifying that facial assessment and selfie-modifying apps articulate the immoderate monitoring (Mihăilă et al., 2016; Mihăilă, 2017; Mihăilă, 2018) of women's bodies. This research endeavors to elucidate whether aesthetic self-tracking and modifying apps enable enhancement of social media images (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021; Morrison and Lăzăroiu, 2021) in terms of facial beautification. Our contribution is by integrating research findings indicating that aesthetic comparing apps algorithmically appraise face and body perception.

2. Theoretical Overview of the Main Concepts

Algorithmic analysis of physical appearance is progressively mediated by smartphone. Beauty apps are engineered to inspect, rate, assess, monitor, or optimize physical appearance. Facial editing apps enable thorough and structural edits where contours can be completely reconfigured. Beauty filters give images a distorted impression when employed unreasonably. Beauty filters lead to unauthentic and factitious expectations of physical appearance. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), machine-driven facial retouching, digital filter-based beauty apps, and image datafication (section 4), augmented reality

beauty apps, facial retouching behaviors, and body-enhancing technologies (section 5), aesthetic self-monitoring devices, perceived facial attractiveness, and beauty retouching (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout April 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "beauty apps," "face filter apps," "beauty filter apps," and "facial editing apps." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2017 and 2021 was analyzed, only 144 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/ inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 20, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Beauty apps	52	7
Face filter apps	35	5
Beauty filter apps	34	4
Facial editing apps	23	4
Type of paper		
Original research	90	19
Review	19	1
Conference proceedings	21	0
Book	8	0
Editorial	6	0

Source: Processed by the authors. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Beauty apps are engineered to inspect, rate, assess, monitor, or optimize physical appearance. Using augmented reality, face filter apps shape behavioral intentions.	Cowan et al., 2021; Elias and Gill, 2018; Fastoso et al., 2021; Taffel, 2021
Beauty apps articulate a technology of confidence-building buckling down to users' anxiety as regards their physical appearance. Selfie-modification apps are typified by incorporated visual filters designed for depicting digital self-portraits in an idealized manner.	Elias and Gill, 2018; Peng, 2021; Rodner et al., 2022; Stewart and Clayton, 2021
Aesthetic self-tracking and modifying apps enable enhancement of social media images in terms of facial beautification.	Butt et al., 2022; Cristel et al., 2021; Elias and Gill, 2018; Goyal and Jerold, 2021; Sheriff and Mageo, 2019
Facial assessment and selfie-modifying apps articulate the immoderate monitoring of women's bodies. Augmented reality beauty apps are captivating and interactive, shaping consumer shopping behavior in persisting in harnessing body-enhancing technologies.	Butt et al., 2022; Cristel et al., 2021; Elias and Gill, 2018; Ota and Nakano, 2021
Beauty apps bridge filters and selfie-alteration technologies, providing guidance as regards optimizing physical appearance.	Elias and Gill, 2018; Gill, 2017; Ota and Nakano, 2021
Beautifying filters harness simulated accessories and amend facial features, assisting users in integrating augmented reality technology. Body comparison predispositions with other persons result in increased selfie editing.	Barker, 2020; Elias and Gill, 2018; Fastoso et al., 2021; Gill, 2017
Filtering images on social media platforms results in devising fashionable types of public recognition.	Dango, 2020; Elias and Gill, 2018; Ota and Nakano, 2021; Sun, 2021
Photo editing apps constitute a risk determinant for users' body image concerns.	Elias and Gill, 2018; Sun, 2021; Swerzenski, 2021; Wang et al., 2020
Augmented reality face filters influence users' well-being in terms of self-approval and positive affect. Appearance apps as aesthetic self-monitoring devices reconfigure beauty culture.	Cristel et al., 2021; Eldaly and Mashaly, 2021; Elias and Gill, 2018; Fastoso et al., 2021; Javornik et al., 2022; Lavrence and Cambre, 2020

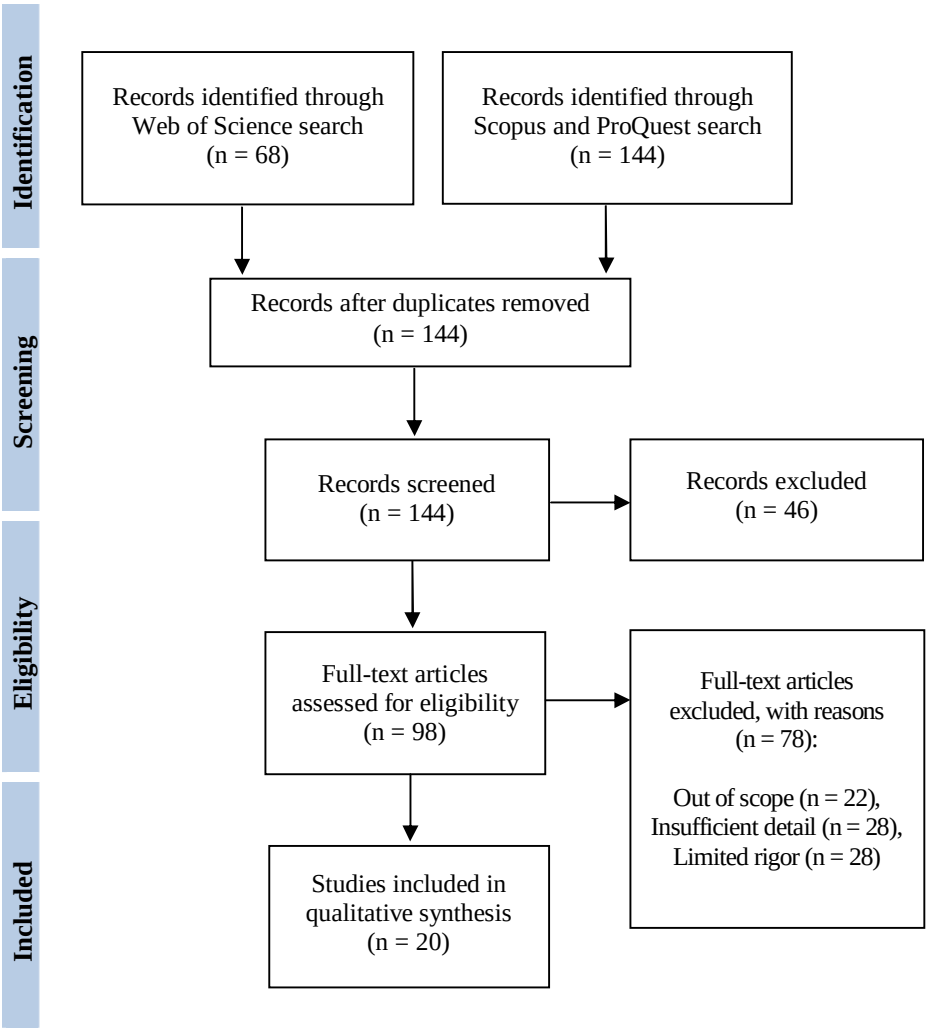


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

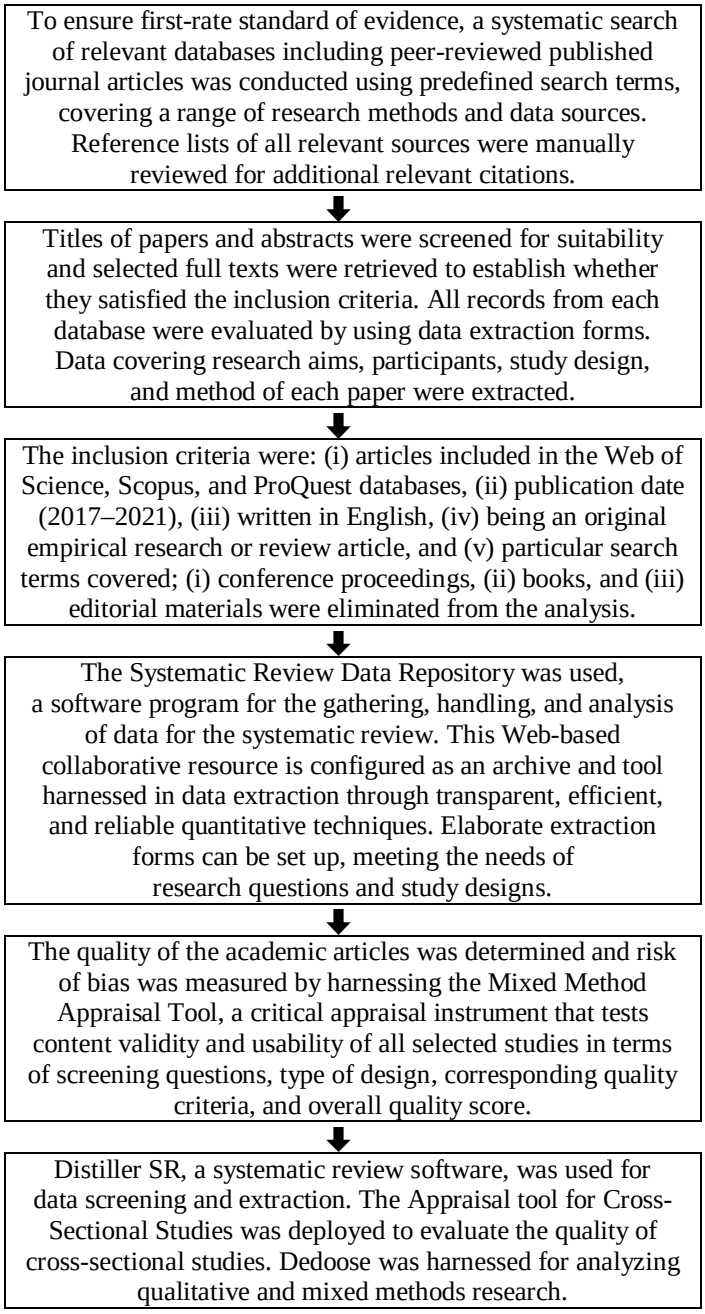


Figure 2 Screening and quality assessment tools

4. Machine-driven Facial Retouching, Digital Filter-based Beauty Apps, and Image Datafication

Beauty apps are engineered (Cowan et al., 2021; Elias and Gill, 2018; Fastoso et al., 2021; Taffel, 2021) to inspect, rate, assess, monitor, or optimize physical appearance. Beauty apps focus on women as active, time-starved, sensible consumers fancying swift, unchallenging, and fun stuff, to express or materialize their attractiveness potential. The symbolic operations of machine-driven facial retouching and image datafication integrate automation and algorithmic processing within the social fabric of dataveillance and platform capitalism. Using augmented reality, face filter apps shape behavioral intentions. Low self-image and cybervictimization are positively related to selfie editing.

Body-enhancing technologies and face-filters that harness augmented reality (Elias and Gill, 2018; Peng, 2021; Rodner et al., 2022; Stewart and Clayton, 2021) articulate digitized body dysmorphia. Selfie-modification apps are typified by incorporated visual filters designed for depicting digital self-portraits in an idealized manner, consonantly duplicating exemplary or normative femininity images. Digital filter-based beauty apps articulate a technology of confidence-building buckling down to female users' anxiety as regards their physical appearance. Escalated photo-manipulation behaviors have resulted in the extent of actual–ideal self-inconsistencies.

Beauty apps, by leveraging big data and machine learning algorithms (Butt et al., 2022; Cristel et al., 2021; Elias and Gill, 2018; Goyal and Jerold, 2021; Sheriff and Mageo, 2019), supply personalized skincare products in terms of concerns and purposes. Aesthetic self-tracking and modifying apps enable enhancement of social media images in terms of facial beautification. Augmented reality apps assist beauty firms in configuring and designing immersive experience services. Visual modes of self-making and subjectivities are adjusted to progressive styles of self-representation through techno-mediated practices. Filtered selfies may lead to an interest in facial plastic surgery, possibly resulting in snapchat dysmorphia. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Beauty apps are engineered to inspect, rate, assess, monitor, or optimize physical appearance.	Cowan et al., 2021; Elias and Gill, 2018; Fastoso et al., 2021; Taffel, 2021
Beauty apps articulate a technology of confidence-building buckling down to users' anxiety as regards their physical appearance.	Elias and Gill, 2018; Peng, 2021; Rodner et al., 2022; Stewart and Clayton, 2021
Aesthetic self-tracking and modifying apps enable enhancement of social media images in terms of facial beautification.	Butt et al., 2022; Cristel et al., 2021; Elias and Gill, 2018; Goyal and Jerold, 2021; Sheriff and Mageo, 2019

5. Augmented Reality Beauty Apps, Facial Retouching Behaviors, and Body-Enhancing Technologies

Facial assessment and selfie-modifying apps (Butt et al., 2022; Cristel et al., 2021; Elias and Gill, 2018; Ota and Nakano, 2021) articulate the immoderate monitoring of women's bodies, as the suble, metricized, and algorithmic analysis of physical appearance is progressively mediated by smartphone. Augmented reality beauty apps are captivating and interactive, shaping consumer shopping behavior in persisting in harnessing body-enhancing technologies. Beauty filters, used for retouching photos to strike as more appealing on social media, give images a distorted impression when employed unreasonably. Beauty filters configure a fuzzy frame of reference of one's self and lead to unauthentic and factitious expectations of physical appearance.

By deploying beauty filter apps, facial retouching behaviors (Elias and Gill, 2018; Gill, 2017; Ota and Nakano, 2021) develop on positive modulation that stimulates the reward system. Selfie-modification apps assist in configuring fashionable racialized bodies by use of digital technologies. Beauty apps bridge filters and selfie-alteration technologies, providing guidance as regards optimizing physical appearance: surgery testing apps assist users in visualizing reconfigured faces and bodies after surgical enhancement, aesthetic comparing apps algorithmically appraise face and body perception, and smartphone-based assessment apps deploy the camera functions to scrutinize the body for imperfections.

Beautifying filters harness simulated accessories and amend facial features (Barker, 2020; Elias and Gill, 2018; Fastoso et al., 2021; Gill, 2017), assisting users in integrating augmented reality technology, straightening out imagination and assertiveness, as with maquillage and wardrobe, while fashioning social connections. Metric systems of evaluation and surveillance articulated by beauty apps configure women's refined visual mastery in terms of digital aesthetic self-monitoring. Beauty apps shape the gendered computed self of neoliberalism by supervising and improving user's body. Body comparison predispositions with other persons result in increased selfie editing. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Facial assessment and selfie-modifying apps articulate the immoderate monitoring of women's bodies.	Butt et al., 2022; Cristel et al., 2021; Elias and Gill, 2018; Ota and Nakano, 2021
Beauty apps bridge filters and selfie-alteration technologies, providing guidance as regards optimizing physical appearance.	Elias and Gill, 2018; Gill, 2017; Ota and Nakano, 2021
Beautifying filters harness simulated accessories and amend facial features, assisting users in integrating augmented reality technology.	Barker, 2020; Elias and Gill, 2018; Fastoso et al., 2021; Gill, 2017

6. Aesthetic Self-Monitoring Devices, Perceived Facial Attractiveness, and Beauty Retouching

Beauty apps remodel (Dango, 2020; Elias and Gill, 2018; Ota and Nakano, 2021; Sun, 2021) the gendered principles of postfeminist self-capitalisation, developed on continuous attractiveness surveillance. The fluid networking between the nucleus accumbens and amygdala triggers the variable alteration in perceived facial attractiveness, contingent upon the degree of beauty retouching. Filtering images on social media platforms results in devising fashionable types of public recognition by refining the affect of users within a certain setting, thus constituting a reaction to a sweeping sense of dissatisfaction. Selfie editing is positively related to taking into account cosmetic surgery.

Photo editing apps constitute a risk determinant for users' body image concerns (Elias and Gill, 2018; Sun, 2021; Swerzenski, 2021; Wang et al., 2020) and for interest in cosmetic surgery. Selfie-modification apps escalate the magnitude to which users' body and face are designed as visible commodifying items. Grasping the factualness of visual content necessitates a technical expertise as regards the operations leading to the creation of images. The deployment of filtered images and photo editing has resulted in snapchat and selfie dysmorphia, in relation to social media-induced discontent with physical appearance.

Appearance apps as aesthetic self-monitoring devices (Cristel et al., 2021; Eldaly and Mashaly, 2021; Elias and Gill, 2018; Fastoso et al., 2021; Javornik et al., 2022; Lavrence and Cambre, 2020) reconfigure beauty culture by surveillance of women's body and face. Facial editing apps enable thorough and structural edits where contours can be completely reconfigured. Taking and posting selfies considerably intensify social anxiety and intentions to undergo cosmetic surgery. Augmented reality face filters influence users' well-being in terms of self-approval and positive affect. Filtered selfies have modified the perception of beauty, resulting in a more feminine image. Selfie editing is positively related to social media addiction and negatively related to life satisfaction. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Filtering images on social media platforms results in devising fashionable types of public recognition.	Dango, 2020; Elias and Gill, 2018; Ota and Nakano, 2021; Sun, 2021
Photo editing apps constitute a risk determinant for users' body image concerns.	Elias and Gill, 2018; Sun, 2021; Swerzenski, 2021; Wang et al., 2020
Augmented reality face filters influence users' well-being in terms of self-approval and positive affect.	Cristel et al., 2021; Eldaly and Mashaly, 2021; Elias and Gill, 2018; Fastoso et al., 2021; Javornik et al., 2022; Lavrence and Cambre, 2020

7. Discussion

We integrate our systematic review throughout research indicating how aesthetic self-tracking and modifying apps enable enhancement of social media images in terms of facial beautification. Our research complements recent analyses clarifying how beauty apps provide guidance as regards optimizing physical appearance. We elucidate, by cumulative evidence, previous research demonstrating how photo editing apps constitute a risk determinant for users' body image concerns

8. Synopsis of the Main Research Outcomes

Aesthetic comparing apps algorithmically appraise face and body perception. Using augmented reality, face filter apps shape behavioral intentions. Selfie-modification apps are typified by incorporated visual filters designed for depicting digital self-portraits in an idealized manner. Filtered selfies may lead to an interest in facial plastic surgery. Beautifying filters assist users in integrating augmented reality technology.

9. Conclusions

Relevant research has investigated whether digital filter-based beauty apps articulate a technology of confidence-building buckling down to female users' anxiety as regards their physical appearance. This systematic literature review presents the published peer-reviewed sources covering the variable alteration in perceived facial attractiveness as contingent upon the degree of beauty retouching. The research outcomes drawn from the above analyses indicate that facial assessment and selfie-modifying apps articulate the im-moderate monitoring of women's bodies.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2018 and 2021, relevant sources on big data-driven facial retouching, aesthetic self-monitoring devices, and augmented reality-based body-enhancing technologies may have been excluded. Limitations of this research comprise particular kinds of publi-cations (original empirical research and review articles) discounting others (conference proceedings articles, books, and editorial materials). The scope of our study also does not move forward the inspection of appearance apps as aesthetic self-monitoring devices. Subsequent analyses should develop on body-enhancing technologies and face-filters that harness augmented reality. Future research should thus investigate snapchat and selfie dysmorphia.

Attention should be directed to how filtered selfies have led to an interest in facial plastic surgery.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The editors declare no conflict of interest in the review and publication decision regarding this article.

Transparency statement
The authors affirm that the manuscript represents an honest, accurate, and transparent account of the research being reported, that no relevant aspects of the study have been left out, and that any inconsistencies from the research as planned (and, if significant, registered) have been clarified.

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Algorithmically Monitoring Menstruation, Ovulation, and Pregnancy by Use of Period and Fertility Tracking Apps

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ABSTRACT. I draw on a substantial body of theoretical and empirical research on algorithmically monitoring menstruation, ovulation, and pregnancy by use of period and fertility tracking apps. With increasing evidence of menstrual tracking and fertility apps, markers of ovulation, and reproductive monitoring, there is an essential demand for comprehending whether fertility-based apps monitor patterns and discontinuations in user's cycle, track average cycle or period duration, and determine approaching menstrual cycle. In this research, prior findings were cumulated indicating that fertility tracking apps are developed on cutting-edge algorithms for personalized determination of the fertile window by resorting to basal body temperature and additional physiological parameters. I carried out a quantitative literature review of ProQuest, Scopus, and the Web of Science throughout June 2021, with search terms including "female reproductive health apps," "fertility tracking mobile apps," "menstrual tracking and fertility apps," and "period and fertility tracking apps." As I analyzed research published between 2019 and 2021, only 167 papers met the eligibility criteria. By removing controversial or unclear findings (scanty/unimportant data), results unsupported by replication, undetailed content, or papers having quite similar titles, I decided on 20, chiefly empirical, sources. Subsequent analyses should develop on bio-sensing technologies that can elucidate physiological processes. Future research should thus investigate how menstrual and gendered surveillance tools articulate reproductive technologies. Attention should be directed to the use of machine learning algorithms in female reproductive health apps.

Keywords: period; fertility; tracking app; menstrual; gender; surveillance tool

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on algorithmically monitoring menstruation, ovulation, and pregnancy by use of period and fertility tracking apps and integrate the insights it configures on menstrual tracking and fertility apps, markers of ovulation, and reproductive monitoring. By analyzing the most recent (2019–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that female reproductive health apps can assess the menstrual cycle fertile window in conformity with the user's menstrual period start dates. The actuality and novelty of this study are articulated by addressing algorithmic monitoring of menstruation, ovulation, and pregnancy, that is an emerging topic involving much interest. My research problem is whether fertility-based apps monitor patterns and discontinuations in user's cycle, track average cycle or period duration, and determine approaching menstrual cycle.

In this review, prior findings have been cumulated indicating that fertility tracking apps are developed on cutting-edge algorithms for personalized determination of the fertile window by resorting to basal body temperature and additional physiological parameters. The identified gaps advance how female reproductive health apps are integrated in displaying fertility cycles. My main objective is to indicate that fertility awareness-based mobile apps can document thorough menstrual cycle data. This systematic review contributes to the literature on algorithmically monitoring menstruation, ovulation, and pregnancy by use of period and fertility tracking apps by clarifying that algorithm-based fertility apps assist users in comprehending menstrual cycles and their health by use of big data analytics (Mihăilă, 2017; Mihăilă, 2018) and machine learning algorithms. This research endeavors to elucidate whether menstrual tracking and fertility apps assist in reproductive monitoring by harnessing predictive algorithms (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021; Morrison and Lăzăroiu, 2021) to establish ovulation and fertility windows. My contribution is by integrating research findings indicating that period and fertility tracking apps assist users in connecting their lives with their menstrual cycles.

2. Theoretical Overview of the Main Concepts

Menstrual trackers are engineered to track, monitor, and handle users' menstrual cycle and ovulation/fertility window. Fertility tracking apps vary in their intrinsic procedures of predicting fertile days. Period tracker apps have to provide users with precise data in terms of day of ovulation and the fertile window predicted by harnessing a marker of ovulation. Women can

determine their distinct natural conception chances to identify their fertility window in terms of symptom tracking and ovulation prediction by use of individualized information. Fertility tracking mobile apps ground their predictions as regards the fertile window exclusively on menstrual cycle features. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), female reproductive health apps are integrated in displaying fertility cycles (section 4), menstrual tracking and fertility apps, markers of ovulation, and reproductive monitoring (section 5), algorithmic monitoring of menstruation, ovulation, and pregnancy (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout June 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "female reproductive health apps," "fertility tracking mobile apps," "menstrual tracking and fertility apps," and "period and fertility tracking apps." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2019 and 2021 was analyzed, only 167 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 20, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Female reproductive health apps	39	4
Fertility tracking mobile apps	38	5
Menstrual tracking and fertility apps	41	5
Period and fertility tracking apps	49	6
Type of paper		
Original research	128	19
Review	16	1
Conference proceedings	12	0
Book	4	0
Editorial	7	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Menstrual trackers are engineered to track, monitor, and handle users' menstrual cycle and ovulation/ fertility window. Fertility awareness-based mobile apps can document thorough menstrual cycle data.	Bull et al., 2019; Ford et al., 2021; Kressbach, 2021; Pichon et al., 2021
Female reproductive health apps are integrated in displaying fertility cycles, articulating the pre-pregnant reproductive body. Fertility tracking mobile apps ground their predictions as regards the fertile window exclusively on menstrual cycle features.	Ford et al., 2021; Hamper, 2020; Johnson et al., 2020; Kressbach, 2021
Female reproductive health apps can assess the menstrual cycle fertile window in conformity with the user's menstrual period start dates. Female reproductive health apps aim to transition from monitoring fertility to comprising a wide-ranging representation of users' health.	Figueiredo et al., 2021; Ford et al., 2021; Jennings et al., 2019a; Kressbach, 2021
Fertility tracking apps are developed on cutting-edge algorithms for personalized determination of the fertile window. Period tracker apps have to provide users with precise data in terms of day of ovulation and the fertile window predicted by harnessing a marker of ovulation.	Bull et al., 2019; Figueiredo et al., 2021; Kressbach, 2021; Worsfold et al., 2021
Menstrual tracking and fertility apps assist in reproductive monitoring by harnessing predictive algorithms to establish ovulation and fertility windows. Period and fertility tracking apps reconfigure values, norms, and rationalities as regards reproductive technologies.	Boydell and Dow, 2021; Gilman, 2021; Hamper, 2020; Kressbach, 2021
Algorithm-based fertility apps assist users in comprehending menstrual cycles and their health by use of big data analytics and machine learning. Users rely on the predictions of menstrual cycle tracking apps to avoid pregnancy or to optimize conception chances.	Gilman, 2021; Kressbach, 2021; Pichon et al., 2021; Zwingerman et al., 2020
Algorithm-based fertility apps aim to track the menstrual cycle and fertility window. Period and fertility tracking apps can further gynaecological health as regards contraception, fertility, and menstrual awareness.	Ali et al., 2021; Al-Rshoud et al., 2021; Kalampalikis et al., 2021; Kressbach, 2021
Users of period and fertility tracking apps are integrated in the dynamics of monitoring and discontinuing indications of menstruation.	Favaro et al., 2021; Hamper, 2020; Kressbach, 2021; Mishra and Suresh, 2021
Specialized smartphone apps can provide users with data as regards fertile days throughout their periods and can be used for pregnancy prevention by use of tailored, biometric data.	Blair et al., 2021; Jennings et al., 2019b; Kressbach, 2021; van de Wiel, 2019

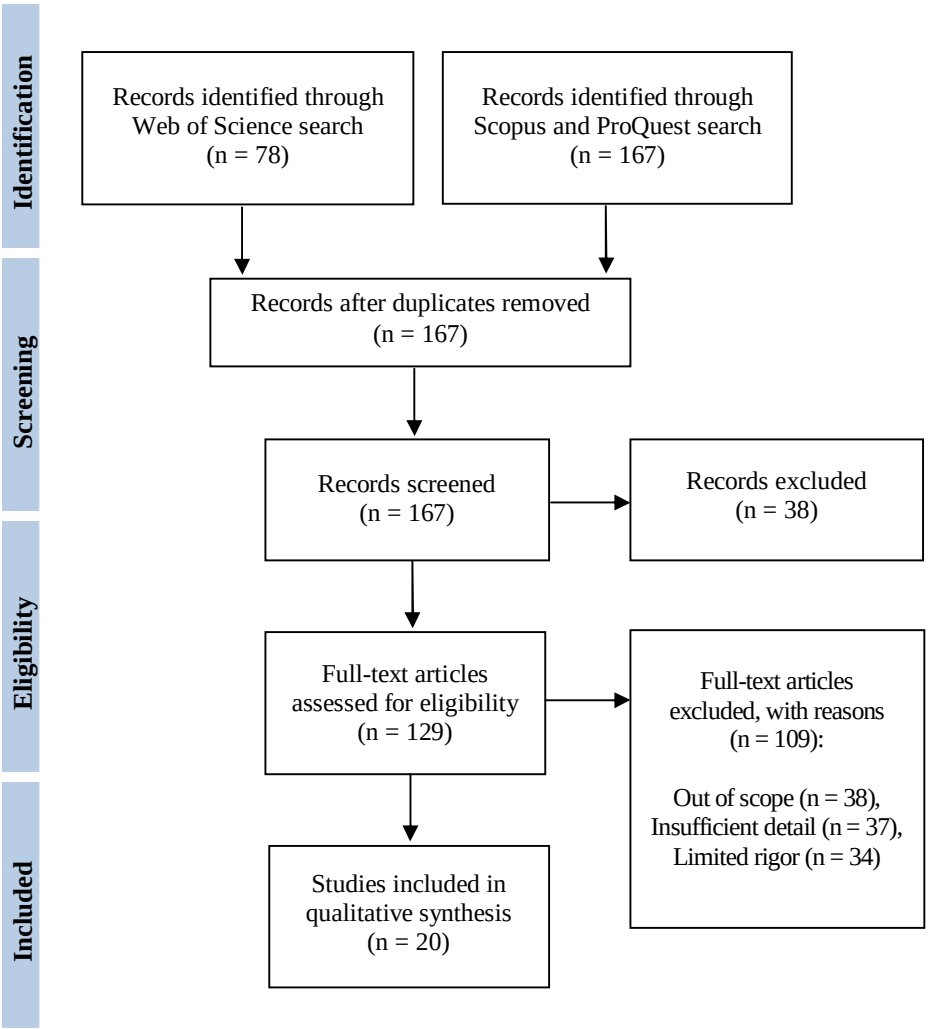


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

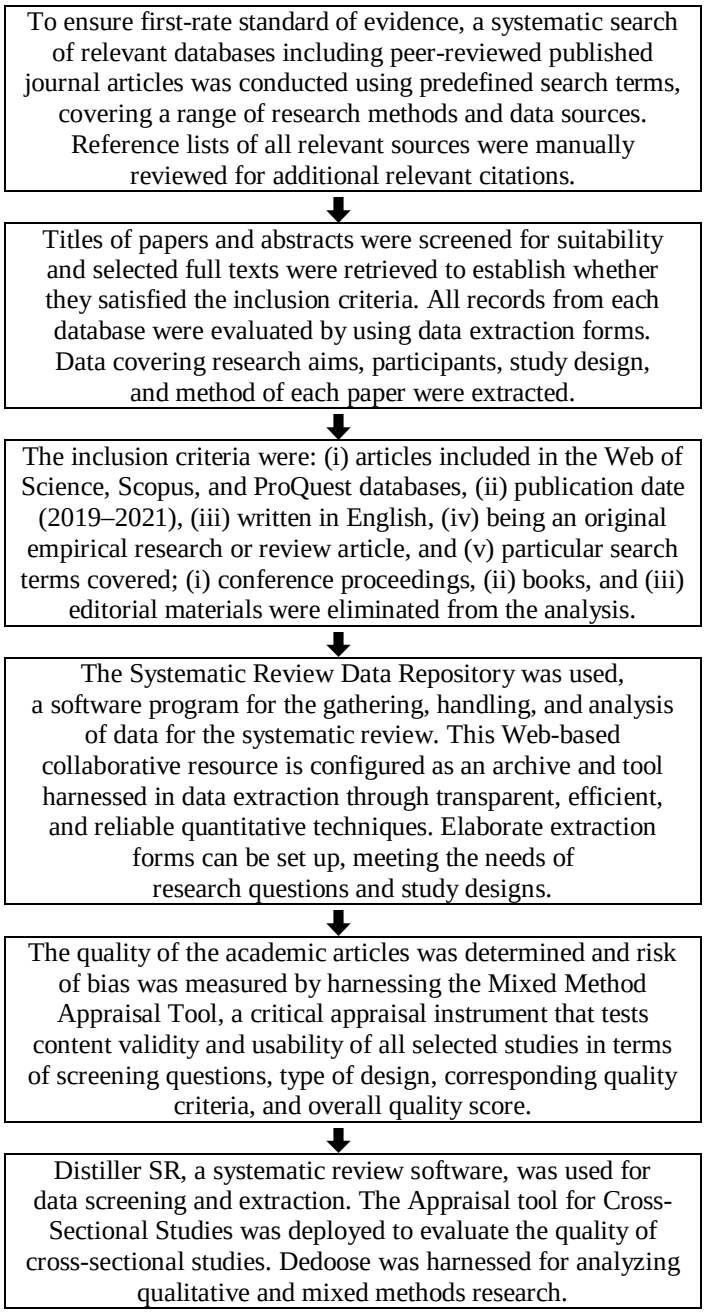


Figure 2 Screening and quality assessment tools

4. Female Reproductive Health Apps Are Integrated in Displaying Fertility Cycles

Female reproductive health apps are considerably integrated in displaying fertility cycles (Ford et al., 2021; Hamper, 2020; Johnson et al., 2020; Kressbach, 2021), articulating the pre-pregnant reproductive body. Logging personal data continuously leads to a significant record of daily behaviors, states of mind, symptoms, and activities, thus informing the predictive algorithm and supplying users of fertility-based apps with a device to monitor patterns and discontinuations in their cycle, track average cycle or period duration, and determine approaching menstrual cycle. Fertility tracking mobile apps ground their predictions as regards the fertile window exclusively on menstrual cycle features. Fertility tracking mobile apps capture data as regards bleeding, temperature that designates ovulation, sexual activity, cramping, heaviness and color of flow, vaginal discharge, mood, libido, sleep quality, etc.

Menstrual trackers are engineered to track, monitor, and handle users' cycle and ovulation/fertility window (Bull et al., 2019; Ford et al., 2021; Kressbach, 2021; Pichon et al., 2021), while assisting them in developing menstrual awareness, regulating their periods, and keeping their menstrual status secret. Menstrual tracking and fertility apps are promoted as devices for self-empowerment by use of self-scrutiny. Fertility awareness-based mobile apps can document thorough menstrual cycle data. Hormonal self-monitoring through period tracking apps assists users in attaining a feeling of experience control.

Female reproductive health apps can assess the menstrual cycle fertile window (Figueiredo et al., 2021; Ford et al., 2021; Jennings et al., 2019a; Kressbach, 2021) in conformity with the user's menstrual period start dates: machine learning algorithms adjust incessantly to cycles and inform women of reduced and increased fertility days. Fertility apps aim to track particular life purposes and heterogeneous user experiences. Tracking continuously can enable users of fertility-based apps to predict, handle, and put an end to the physiological excess and excretion confidentially. Female reproductive health apps aim to transition from monitoring fertility to comprising a wide-ranging representation of users' health. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Menstrual trackers are engineered to track, monitor, and handle users' menstrual cycle and ovulation/fertility window.	Bull et al., 2019; Ford et al., 2021; Kressbach, 2021; Pichon et al., 2021
Female reproductive health apps are integrated in displaying fertility cycles, articulating the pre-pregnant reproductive body.	Ford et al., 2021; Hamper, 2020; Johnson et al., 2020; Kressbach, 2021
Female reproductive health apps can assess the menstrual cycle fertile window in conformity with the user's menstrual period start dates.	Figueiredo et al., 2021; Ford et al., 2021; Jennings et al., 2019a; Kressbach, 2021

5. Menstrual Tracking and Fertility Apps, Markers of Ovulation, and Reproductive Monitoring

Fertility tracking apps are developed on cutting-edge algorithms for personalized determination of the fertile window (Bull et al., 2019; Figueiredo et al., 2021; Kressbach, 2021; Worsfold et al., 2021) by resorting to basal body temperature and additional physiological parameters. Fertility apps can be deployed as data storage tools. Fertility smartphone apps are not engineered to enable women to alter or influence their cycles. Period tracker apps have to provide users with precise data in terms of day of ovulation and the fertile window predicted by harnessing a marker of ovulation (e.g., body temperature, symptoms, emotional states, ovulation sticks, or cervical mucus).

Menstrual tracking and fertility apps assist in reproductive monitoring (Boydell and Dow, 2021; Gilman, 2021; Hamper, 2020; Kressbach, 2021) by harnessing predictive algorithms to establish ovulation and fertility windows. App-based fertility tracking can emerge as a consequential reproductive device in a society that attaches importance to self-expertise and monitoring. Menstrual and gendered surveillance tools inaccurately assist women in tracking their periods and handling their fertility, with algorithmically determined outcomes. Period and fertility tracking apps reconfigure values, norms, and rationalities as regards reproductive technologies.

Algorithm-based fertility apps assist users in comprehending menstrual cycles and their health (Gilman, 2021; Kressbach, 2021; Pichon et al., 2021; Zwingerman et al., 2020) by use of big data analytics and machine learning. Users rely on the predictions of menstrual cycle tracking apps to avoid pregnancy or to optimize conception chances. Data collected by female reproductive health apps cannot be deleted, and thus users can be tracked perpetually with preliminary conjectures or speculations as regards their childbirth and fertility. Menstrual trackers illustrate a significantly normative representation of women, harnessing machine learning algorithms to clarify inconsistency in cycles. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Fertility tracking apps are developed on cutting-edge algorithms for personalized determination of the fertile window.	Bull et al., 2019; Figueiredo et al., 2021; Kressbach, 2021; Worsfold et al., 2021
Menstrual tracking and fertility apps assist in reproductive monitoring by harnessing predictive algorithms to establish ovulation and fertility windows.	Boydell and Dow, 2021; Gilman, 2021; Hamper, 2020; Kressbach, 2021
Algorithm-based fertility apps assist users in comprehending menstrual cycles and their health by use of big data analytics and machine learning.	Gilman, 2021; Kressbach, 2021; Pichon et al., 2021; Zwingerman et al., 2020

6. Algorithmic Monitoring of Menstruation, Ovulation, and Pregnancy

Period and fertility tracking apps can further gynaecological health (Ali et al., 2021; Al-Rshoud et al., 2021; Kalampalikis et al., 2021; Kressbach, 2021) as regards contraception, fertility, and menstrual awareness. Fertility tracking apps vary in their intrinsic procedures of predicting fertile days. Period and fertility tracking apps assist users in connecting their lives with their menstrual cycles so as to decrease feelings, bodily conditions, and health behaviors to undetected biological process. Algorithm-based fertility apps aim to track the menstrual cycle and fertility window.

Users of period and fertility tracking apps are integrated in the dynamics of monitoring and discontinuing indications of menstruation (Favaro et al., 2021; Hamper, 2020; Kressbach, 2021; Mishra and Suresh, 2021), but their body and moods are recurrently impacted by their unmanageable menstrual cycle. Fertility apps can algorithmically reinforce particular features of embodied reproductive routines, cognizance, and knowledge, and alter the manners in which users are associated with and inspect their bodies by use of data. Fertility tracking apps offer reassurance and are critical in assisting users to assimilate knowledge about their body in terms of the menstrual cycle, the fertile window, subfertility, and female fertility decline. Algorithmically monitoring menstruation, ovulation, and pregnancy entails harnessing biosensing technologies to elucidate physiological processes.

Specialized smartphone apps can provide users with data as regards fertile days throughout their periods (Blair et al., 2021; Jennings et al., 2019b; Kressbach, 2021; van de Wiel, 2019) and can be used for pregnancy prevention by use of tailored, biometric data. Big data-driven period tracker apps attempt to display relationships between logged symptoms and the diverse menstrual cycle phases, configuring coherent and accurate underpinnings for heterogeneous emotional and physical experiences. Women can determine their distinct natural conception chances to identify their fertility window in terms of symptom tracking and ovulation prediction by use of individualized information. Significantly voluminous and automatically produced data sets configure the datafication of conception. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Algorithm-based fertility apps aim to track the menstrual cycle and fertility window.	Ali et al., 2021; Al-Rshoud et al., 2021; Kalampalikis et al., 2021; Kressbach, 2021
Users of period and fertility tracking apps are integrated in the dynamics of monitoring and discontinuing indications of menstruation.	Favaro et al., 2021; Hamper, 2020; Kressbach, 2021; Mishra and Suresh, 2021
Users can identify their fertility window in terms of symptom tracking and ovulation prediction.	Blair et al., 2021; Jennings et al., 2019b; Kressbach, 2021; van de Wiel, 2019

7. Discussion

I integrate my systematic review throughout research indicating how machine learning algorithms adjust incessantly to cycles and inform women of reduced and increased fertility days. My research complements recent analyses clarifying how users can be tracked perpetually by female reproductive health apps with preliminary conjectures or speculations as regards their childbirth and fertility. I elucidate, by cumulative evidence, previous research demonstrating how fertility tracking apps are a reliable component of the conception process.

8. Synopsis of the Main Research Outcomes

Users of period and fertility tracking apps are integrated in the dynamics of monitoring and discontinuing indications of menstruation. Female reproductive health apps are considerably integrated in displaying fertility cycles. Period and fertility tracking apps can further gynaecological health as regards contraception, fertility, and menstrual awareness. Menstrual trackers harness machine learning algorithms to clarify inconsistency in cycles. Users rely on the predictions of menstrual cycle tracking apps to avoid pregnancy or to optimize conception chances. Users' body and moods are recurrently impacted by their unmanageable menstrual cycle. Big data-driven period tracker apps attempt to display relationships between logged symptoms and the diverse menstrual cycle phases.

9. Conclusions

Relevant research has investigated whether specialized smartphone apps can provide users with data as regards fertile days throughout their periods. This systematic literature review presents the published peer-reviewed sources covering how female reproductive health apps aim to transition from monitoring fertility to comprising a wide-ranging representation of users' health. The research outcomes drawn from the above analyses indicate that algorithm-based fertility apps aim to track the menstrual cycle and fertility window.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2019 and 2021, relevant sources on algorithmically monitoring menstruation, ovulation, and pregnancy by use of period and fertility tracking apps may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles), discounting others (conference pro-

ceedings articles, books, and editorial materials). The scope of our study also does not move forward the inspection of wide-ranging representation of users' health. Subsequent analyses should develop on bio-sensing technologies that can elucidate physiological processes. Future research should thus investigate how menstrual and gendered surveillance tools articulate reproductive technologies. Attention should be directed to the use of machine learning algorithms in female reproductive health apps.

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The author confirms being the sole contributor of this work and approved it for publication. The author takes full responsibility for the accuracy and the integrity of the data analysis.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The editors declare no conflict of interest in the review and publication decision regarding this article.

Transparency statement
The author affirms that the manuscript represents an honest, accurate, and transparent account of the research being reported, that no relevant aspects of the study have been left out, and that any inconsistencies from the research as planned (and, if significant, registered) have been clarified.

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The Digital Fabric of Reproductive Technologies: Fertility, Pregnancy, and Menstrual Cycle Tracking Apps

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ABSTRACT. In this article, I cumulate previous research findings indicating that fertility, pregnancy, and menstrual cycle tracking apps configure the digital fabric of reproductive technologies. I contribute to the literature on female reproductive health apps and supportive fertility technologies by showing that fertility awareness-based mobile apps can predict ovulation and optimize the conception chance. Throughout June 2021, I performed a quantitative literature review of the Web of Science, Scopus, and ProQuest databases, with search terms including "period and fertility tracking apps," "female reproductive health apps," "menstrual cycle tracking apps," and "fertility awareness-based mobile apps." As I inspected research published in 2019 and 2021, only 188 articles satisfied the eligibility criteria. By eliminating controversial findings, outcomes unsubstantiated by replication, too imprecise material, or having similar titles, I decided upon 21, generally empirical, sources. Subsequent analyses should develop on the advancement of smartphone apps designed for female reproductive health. Future research should thus investigate the relationship between female-specific health data, digital tools, and self-monitoring and self-tracking connected health devices. Attention should be directed to period and fertility tracking apps as devices that assist health monitoring.

Keywords: fertility; pregnancy; menstrual; tracking app; reproductive technology

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on fertility, pregnancy, and menstrual cycle tracking apps as the digital fabric of reproductive technologies and integrate the insights it configures on female reproductive health apps and supportive fertility technologies. By analyzing the most recent (2019–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that female reproductive health apps and supportive fertility technologies harness body temperature and menstrual cycle records to algorithmically determine the fertile window. The actuality and novelty of this study are articulated by addressing how data as regards fertility can be integrated by use of female reproductive health apps, that is an emerging topic involving much interest. My research problem is whether fertility tracking apps aim to determine fertile days according to standard drivers as regards essential menstrual cycle metrics.

In this review, prior findings have been cumulated indicating that fertility apps have been progressively leveraged to predict ovulation and fertile window. The identified gaps advance how fertility tracking apps can be decisive throughout essential phases of reproductive life. My main objective is to indicate that female reproductive health apps direct attention to users who are preoccupied with fertility. This systematic review contributes to the literature on fertility, pregnancy, and menstrual cycle tracking apps as the digital fabric of reproductive technologies by clarifying that female reproductive health apps aim to assist users in terms of sexual health, contraception, and family planning. This research endeavors to elucidate whether keeping track of the periods and fertility window, mobile health apps assist users (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021; Morrison and Lăzăroiu, 2021) in monitoring their cycles. My contribution is by integrating research findings indicating that fertility awareness-based mobile apps can predict ovulation and optimize the conception chance.

2. Theoretical Overview of the Main Concepts

Period and fertility tracking app track menstrual cycles, ovulation, and fertile days in terms of menstrual flow and cycle length. Such mobile apps are self-tracking technologies for reproductiveness, collecting data associated with fertility, while supplying feedback by use of visualizations. Fertility awareness and pregnancy-related apps significantly refashion reproductive and digital health. The datafication approaches of period and fertility tracking apps may assist in thoroughly inspecting menstrual and reproductive health conditions. Period and fertility tracking apps ask women to conjecture causal

connections between period phases and logged symptoms. The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), female reproductive health apps and supportive fertility technologies (section 4), data as regards fertility can be integrated by use of female reproductive health apps (section 5), fertility awareness-based mobile apps can predict ovulation and optimize the conception chance (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "period and fertility tracking apps," "female reproductive health apps," "menstrual cycle tracking apps," and "fertility awareness-based mobile apps." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2019 and 2021 was analyzed, only 188 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 21, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Period and fertility tracking apps	59	7
Female reproductive health apps	49	5
Menstrual cycle tracking apps	44	5
Fertility awareness-based mobile apps	36	4
Type of paper		
Original research	118	18
Review	17	3
Conference proceedings	22	0
Book	12	0
Editorial	19	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

The advancement of smartphone apps designed for female reproductive health configures cutting-edge types and routines of knowledge production.	Baldwin, 2019; Hamper, 2020; Kressbach, 2021
Period and fertility tracking apps are devices that assist health monitoring. Digital fertility awareness-based methods of pregnancy prevention are fashionable among users who are planning a pregnancy in time and would like to assimilate knowledge as regards their distinct menstrual cycle.	Earle et al., 2021; Johnson et al., 2020; Kressbach, 2021; Pearson et al., 2021
Female reproductive health apps and supportive fertility technologies harness body temperature and menstrual cycle records to algorithmically determine the fertile window. Fertility apps have been progressively leveraged to predict ovulation and fertile window.	Figueiredo et al., 2020; Healy, 2021; Kressbach, 2021; Simmons and Jennings, 2020
Period and fertility tracking apps ask women to conjecture causal connections between period phases and logged symptoms. Fertility tracking apps aim to determine fertile days according to standard drivers as regards essential menstrual cycle metrics	Bull et al., 2019; Figueiredo et al., 2021; Kressbach, 2021
Period and fertility tracking apps enable users to thoroughly analyze and decide on their body and health. Integrating data as regards fertility by use of female reproductive health apps can optimize subsequent chances of pregnancy.	Bull et al., 2019; Hamper, 2020; Kressbach, 2021; Worsfold et al., 2021
Female reproductive health apps direct attention to users who are preoccupied with fertility. Fertility awareness and pregnancy-related apps significantly refashion reproductive and digital health.	Ford et al., 2021a; French et al., 2020; Gilman, 2021; Kressbach, 2021
Female reproductive health apps aim to assist users in terms of sexual health, contraception, and family planning. Period tracking apps ask users to articulate their lives by monitoring their menstrual cycle.	Figueiredo et al., 2021; Ford et al., 2021b; Karim and Talhouk, 2021; Kressbach, 2021
Fertility awareness-based mobile apps can predict ovulation and optimize the conception chance. Keeping track of the periods and fertility window, mobile health apps assist users in monitoring their cycles.	Al-Rshoud et al., 2021; Favaro et al., 2021; Hamper, 2020
Fertility tracking mobile apps instruct women as regards cycle phases and symptoms through female reproductive health apps. Period and fertility tracking app track menstrual cycles, ovulation, and fertile days in terms of menstrual flow and cycle length.	Blair et al., 2021; Ford et al., 2021a; Grieger and Norman, 2020; Kressbach, 2021

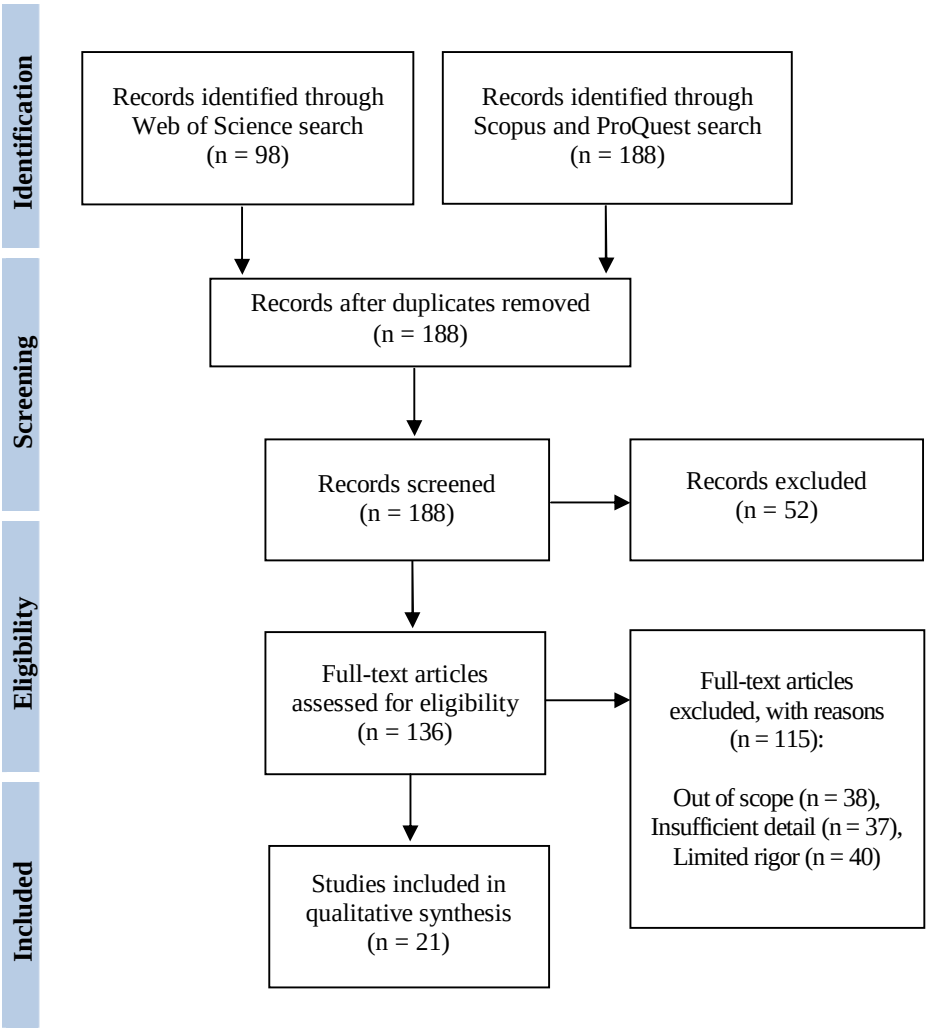


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

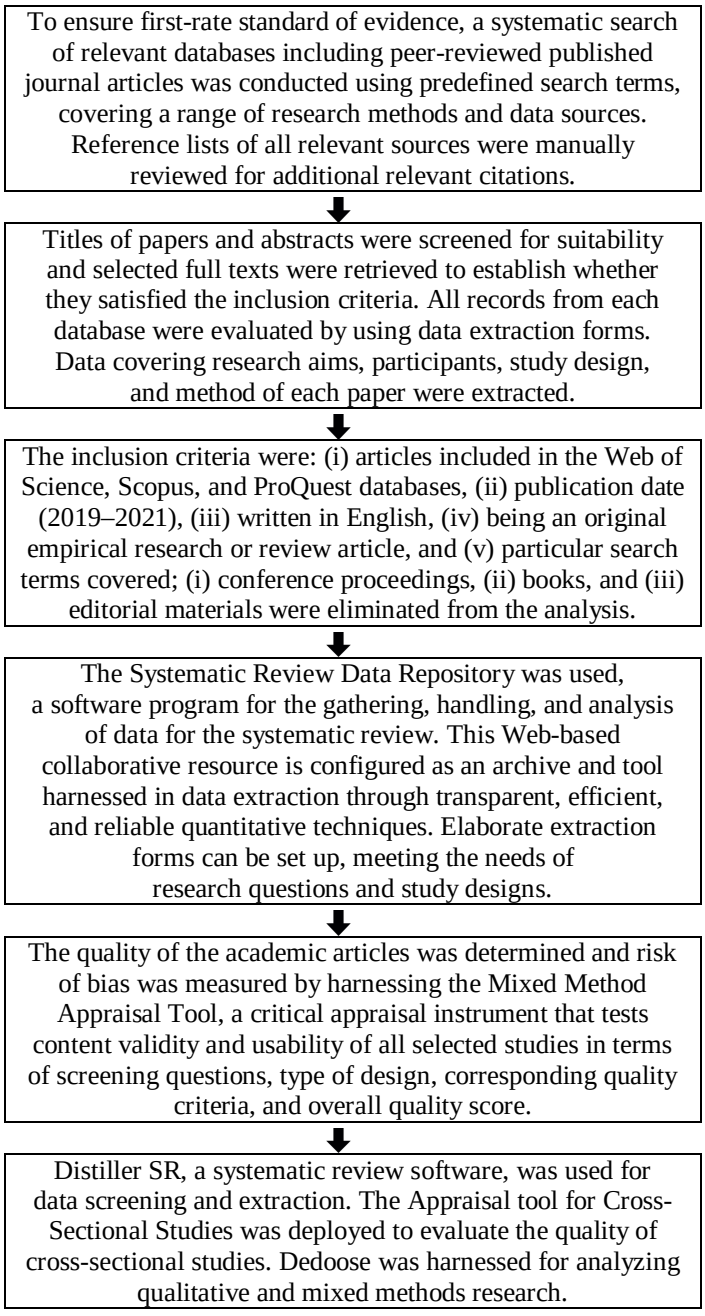


Figure 2 Screening and quality assessment tools

4. Female Reproductive Health Apps and Supportive Fertility Technologies

The advancement of smartphone apps designed for female reproductive health (Baldwin, 2019; Hamper, 2020; Kressbach, 2021) configures cutting-edge types and routines of knowledge production as regards reproductive bodies and processes. The log transfers knowledge to the analytic sections of fertility-based apps, and thus menstrual cycle phases can be clarified. By leveraging fertility risk personalized technologies, women can attain the objectives of hegemonic femininity and put into practice standards of behavior related to reproductive citizenship.

Digital fertility awareness-based methods of pregnancy prevention (Earle et al., 2021; Johnson et al., 2020; Kressbach, 2021; Pearson et al., 2021) constitute a groundbreaking course of action to hormonal/invasive birth control, and are fashionable among users who are planning a pregnancy in time and would like to assimilate knowledge as regards their distinct menstrual cycle. Driving forces for fertility app deployment differ, interrelate, and modify over time. The menstrual cycle represents an indirect assessment of health that can be leveraged as a metric for the regulation of physiological processes, and period and fertility tracking apps are devices that assist health monitoring. Imprecise data on the fertile period provided by female reproductive health apps may be deleterious to chances of conceiving.

Female reproductive health apps and supportive fertility technologies harness body temperature and menstrual cycle records (Figueiredo et al., 2020; Healy, 2021; Kressbach, 2021; Simmons and Jennings, 2020) to algorithmically determine the fertile window. Fertility apps can be instrumental in the cutting-edge pathologization and reconfiguration of users' bodies as big data-driven newly-digitalized reproductive machines. Big data analytics and visual approaches may fortify gendered stereotypes and discredit as regards menstruation through digital fertility apps. Fertility apps have been progressively leveraged to predict ovulation and fertile window. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

The advancement of smartphone apps designed for female reproductive health configures cutting-edge types and routines of knowledge production.	Baldwin, 2019; Hamper, 2020; Kressbach, 2021
Period and fertility tracking apps are devices that assist health monitoring.	Earle et al., 2021; Johnson et al., 2020; Kressbach, 2021; Pearson et al., 2021
Female reproductive health apps and supportive fertility technologies harness body temperature and menstrual cycle records to algorithmically determine the fertile window.	Figueiredo et al., 2020; Healy, 2021; Kressbach, 2021; Simmons and Jennings, 2020

5. Data as Regards Fertility Can Be Integrated by Use of Female Reproductive Health Apps

Fertility tracking apps aim to determine fertile days according to standard drivers (Bull et al., 2019; Figueiredo et al., 2021; Kressbach, 2021) as regards essential menstrual cycle metrics (e.g., predictability of cycle, follicular phase and luteal phase – all in terms of duration). Mobile apps are trendsetting self-tracking technologies for reproductiveness, collecting data associated with fertility (e.g., period dates and physical and psychological data), while supplying feedback by use of visualizations (e.g., predicting menstrual cycles, ovulation, and fertility windows). Period and fertility tracking apps do not check reproductive relationships but ask women to conjecture causal connections between period phases and logged symptoms.

Integrating data as regards fertility by use of female reproductive health apps (Bull et al., 2019; Hamper, 2020; Kressbach, 2021; Worsfold et al., 2021) can optimize subsequent chances of pregnancy in terms of medicalized and personalized comprehensions of risk and accountability. Period and fertility tracking apps attempt to be devices for empowerment, configuring self-monitoring and datafication, thus enabling users to thoroughly analyze and decide on their body and health. Fertility tracking apps can be decisive throughout essential phases of reproductive life (e.g., preconception, prenatal period, and birth spacing). Fertility, pregnancy, and menstrual cycle tracking apps should comprise controlling a marker of ovulation to offer predictions as regards ovulation and the fertile window.

Female reproductive health apps direct attention to users who are preoccupied with fertility (Ford et al., 2021a; French et al., 2020; Gilman, 2021; Kressbach, 2021), either attempting to get pregnant or prevent child-bearing. The design of period and fertility tracking apps functions within the current architecture of biomedical power, but their datafication approaches may assist in thoroughly inspecting menstrual and reproductive health conditions. Period and fertility tracking apps can integrate users into a gendered binary that may not correspond with their identity. Fertility awareness and pregnancy-related apps significantly refashion reproductive and digital health. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Period and fertility tracking apps ask women to conjecture causal connections between period phases and logged symptoms.	Bull et al., 2019; Figueiredo et al., 2021; Kressbach, 2021
Period and fertility tracking apps enable users to thoroughly analyze and decide on their body and health.	Bull et al., 2019; Hamper, 2020; Kressbach, 2021; Worsfold et al., 2021
Female reproductive health apps direct attention to users who are preoccupied with fertility.	Ford et al., 2021a; French et al., 2020; Gilman, 2021; Kressbach, 2021

6. Fertility Awareness-based Mobile Apps Can Predict Ovulation and Optimize the Conception Chance

Female reproductive health apps aim to assist users (Figueiredo et al., 2021; Ford et al., 2021b; Karim and Talhouk, 2021; Kressbach, 2021) in terms of sexual health, contraception, and family planning. Period tracking apps ask users to articulate their lives by monitoring their menstrual cycle. Sex and gender may impact embracing female-specific health data, digital tools, and self-monitoring and self-tracking connected health devices. Fertility apps are likely to lack support for the first menstruation cycles or for the escalated unpredictability throughout menopause.

Keeping track of the periods and fertility window, mobile health apps assist users in monitoring their cycles (Al-Rshoud et al., 2021; Favaro et al., 2021; Hamper, 2020) by inspecting the modifications taking place throughout the month and indicating their peak fertility window, thus helping women who want to get pregnant or who plan to use such devices as a contraceptive method. Period and fertility tracking apps, prediction algorithms, big data analytics, and smartphone computing should integrate into users' ordinary practices. The more data the machine learning algorithms collect in relation to a user's menstruation cycles, the more precisely fertility awareness-based mobile apps can predict ovulation and optimize the conception chance.

Period and fertility tracking app track menstrual cycles, ovulation, and fertile days (Blair et al., 2021; Ford et al., 2021a; Grieger and Norman, 2020; Kressbach, 2021) in terms of menstrual flow and cycle length. Fertility tracking mobile apps attempt to make periods less ambiguous by instructing women as regards cycle phases and symptoms through female reproductive health apps. Menstrual cycle tracking apps that can employ a couple's personal features to optimize their predicted conception chance may supply practical data that can facilitate lifestyle modifications and support medical appointment for fertility care. Fertility tracking apps can be deployed for reproductiveness or contraceptive grounds and for period-related experiences (e.g., mood or well-being). (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Female reproductive health apps aim to assist users in terms of sexual health, contraception, and family planning.	Figueiredo et al., 2021; Ford et al., 2021b; Karim and Talhouk, 2021; Kressbach, 2021
Fertility awareness-based mobile apps can predict ovulation and optimize the conception chance.	Al-Rshoud et al., 2021; Favaro et al., 2021; Hamper, 2020
Fertility tracking mobile apps instruct women as regards cycle phases and symptoms through female reproductive health apps.	Blair et al., 2021; Ford et al., 2021a; Grieger and Norman, 2020; Kressbach, 2021

7. Discussion

I integrate our systematic review throughout research indicating how integrating data as regards fertility by use of female reproductive health apps can optimize subsequent chances of pregnancy. My research complements recent analyses clarifying how female reproductive health apps and supportive fertility technologies harness body temperature and menstrual cycle records to algorithmically determine the fertile window. I elucidate, by cumulative evidence, previous research demonstrating how fertility apps have been progressively leveraged to predict ovulation and fertile window.

8. Synopsis of the Main Research Outcomes

Period and fertility tracking apps are devices that assist health monitoring. Fertility awareness-based mobile apps can predict ovulation and optimize the conception chance. Digital fertility awareness-based methods of pregnancy prevention are fashionable among users who are planning a pregnancy in time and would like to assimilate knowledge as regards their distinct menstrual cycle. The menstrual cycle represents an indirect assessment of health that can be leveraged as a metric for the regulation of physiological processes. Imprecise data on the fertile period provided by female reproductive health apps may be deleterious to chances of conceiving.

9. Conclusions

Relevant research has investigated whether period tracking apps ask users to articulate their lives by monitoring their menstrual cycle. This systematic literature review presents the published peer-reviewed sources covering how fertility tracking apps determine fertile days according to standard drivers as regards essential menstrual cycle metrics. The research outcomes drawn from the above analyses indicate that fertility tracking mobile apps instruct women as regards cycle phases and symptoms through female reproductive health apps.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2019 and 2021, relevant sources on fertility, pregnancy, and menstrual cycle tracking apps as the digital fabric of reproductive technologies may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles), discounting others (conference proceedings articles, books, and editorial materials). The scope of my study also does not

move forward the inspection of bodies as big data-driven newly-digitalized reproductive machines. Subsequent analyses should develop on the advancement of smartphone apps designed for female reproductive health. Future research should thus investigate the relationship between female-specific health data, digital tools, and self-monitoring and self-tracking connected health devices. Attention should be directed to period and fertility tracking apps as devices that assist health monitoring.


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The author confirms being the sole contributor of this work and approved it for publication. The author takes full responsibility for the accuracy and the integrity of the data analysis.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Disclosure by the editors of record
The editors declare no conflict of interest in the review and publication decision regarding this article.

Transparency statement
The author affirms that the manuscript represents an honest, accurate, and transparent account of the research being reported, that no relevant aspects of the study have been left out, and that any inconsistencies from the research as planned (and, if significant, registered) have been clarified.

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The Datafication of Fertility and Reproductive Health: Menstrual Cycle Tracking Apps and Ovulation Detection Algorithms

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ABSTRACT. With growing evidence of the datafication of fertility and reproductive health, there is a pivotal need for comprehending menstrual cycle tracking apps and ovulation detection algorithms. In this research, previous findings were cumulated showing that mobile apps advanced to monitor menstrual cycle and symptoms are fashionable for birth control purposes and fertility awareness, and contribute to the literature by indicating that period and fertility trackers as digital health technologies configure users' empowerment by use of robust data. Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was performed, with search terms including "female reproductive health apps," "menstrual cycle tracking apps," "period tracking apps," and "fertility tracking apps." As research published between 2019 and 2021 was inspected, only 176 articles satisfied the eligibility criteria. By taking out controversial or ambiguous findings (insufficient/irrelevant data), outcomes unsubstantiated by replication, too general material, or studies with nearly identical titles, I selected 22 mainly empirical sources. Subsequent analyses should develop on cutting-edge digital technologies and apps designed for handling fertility, menstrual cycles, and reproduction. Future research should thus investigate fertility tracking apps providing predictions as regards fertile days. Attention should be directed to the precision of predicting the fertile window during menstrual cycle tracking.

Keywords: menstrual cycle; tracking app; datafication; fertility; reproductive health

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1. Introduction

The purpose of my systematic review is to examine the recently published literature on the datafication of fertility and reproductive health and integrate the insights it configures on menstrual cycle tracking apps and ovulation detection algorithms. By analyzing the most recent (2019–2021) and significant (Web of Science, Scopus, and ProQuest) sources, my paper has attempted to prove that fertility has been gradually furthered by consumer health technologies (Birtus and Lăzăroiu, 2021; Lăzăroiu et al., 2020; Lyons and Lăzăroiu, 2020; Mitchell and Lăzăroiu, 2021) as mobile apps that assist self-tracking activities. The actuality and novelty of this study are articulated by addressing period and fertility trackers as digital health technologies, that is an emerging topic involving much interest. My research problem is whether, by use of self-learning algorithms, menstrual cycle or period tracking apps enable women to monitor their periods and derive predictions.

In this review, prior findings have been cumulated indicating that period and fertility trackers as digital health technologies configure users' empowerment by use of robust data. The identified gaps advance fertility tracking apps for personal health monitoring. My main objective is to indicate that Fertility apps can support the standardization of fertility tracking as a pivotal component of everyday life. This systematic review contributes to the literature on fertility awareness technologies and the datafication of menstruation by clarifying that apps designed for period tracking and ovulation prediction make dynamic cycle assessments. This research endeavors to elucidate whether menstrual cycle tracking apps monitor users' periods and symptoms, predict ovulation and conception chances, and supply fertility data. My contribution is by integrating research findings indicating that mobile apps advanced to monitor menstrual cycle and symptoms are fashionable for birth control purposes and fertility awareness.

2. Theoretical Overview of the Main Concepts

Algorithm-based fertility apps can determine the fertile window of the period by using a user's menstrual cycle start date. Users attempting to conceive are progressively harnessing fertility-tracking software apps to schedule intercourse. The upsides of deploying an app to assist conception include determination of the fertile days. Period trackers are occasionally unreliable, resulting in unwanted pregnancies. Women can log days of menstrual cycle, descriptors of flow, and related signs and symptoms. Female reproductive health apps focus on users who aim to track period-related health issues. Female reproductive health apps may not be convenient for reliably timing intercourse. Period and fertility tracking apps aim soundness and precision of predictions. The manuscript is organized as following: theoretical overview

(section 2), methodology (section 3), period and fertility trackers as digital health technologies (section 4), fertility tracking apps for personal health monitoring (section 5), fertility awareness technologies and the datafication of menstruation (section 6), discussion (section 7), synopsis of the main research outcomes (section 8), conclusions (section 9), limitations, implications, and further directions of research (section 10).

3. Methodology

Throughout May 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms comprising "female reproductive health apps," "menstrual cycle tracking apps," "period tracking apps," and "fertility tracking apps." The search terms were determined as being the most employed words or phrases across the analyzed literature. As research published between 2019 and 2021 was analyzed, only 176 articles met the suitability criteria. By removing questionable or indeterminate findings (insubstantial/inconsequent data), results unconfirmed by replication, too imprecise content, or having quite similar titles, 22, chiefly empirical, sources were selected (Tables 1 and 2). Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required. (Figures 1 and 2)

Table 1 Topics and types of scientific products identified and selected.

Topic	**Identified**	**Selected**
Female reproductive health apps	42	5
Menstrual cycle tracking apps	45	6
Period tracking apps	41	5
Fertility tracking apps	48	6
Type of paper		
Original research	108	19
Review	17	3
Conference proceedings	24	0
Book	9	0
Editorial	18	0

Source: Processed by the author. Some topics overlap.

Table 2 General synopsis of evidence as regards focus topics and descriptive outcomes (research findings).

Fertility has been gradually furthered by consumer health technologies as mobile apps that assist self-tracking activities.	Figueiredo et al., 2021; Hendl and Jansky, 2021; Kressbach, 2021; Pearson et al., 2021
Female reproductive health apps focus on users who aim to track period-related health issues. App-based fertility tracking can be pivotal for the integrated transition from pregnancy prevention to purposefully enabling child-bearing	Ford et al., 2021a; Hamper, 2020; Johnson et al., 2020; Kressbach, 2021
By use of self-learning algorithms, menstrual cycle or period tracking apps enable women to monitor their periods and derive predictions.	Earle et al., 2021; Johnson et al., 2020; Kressbach, 2021; Worsfold et al., 2021
Period tracking apps transfer to users health technologies aiming self-scrutiny and self-care.	Bull et al., 2019; Figueiredo et al., 2021; Ford et al., 2021b; Kressbach, 2021
Mobile apps advanced to monitor menstrual cycle and symptoms are fashionable for birth control purposes and fertility awareness.	Bull et al., 2019; de Paula Oliveira et al., 2021; Hamper, 2020; Kressbach, 2021
mHealth apps for period tracking typically provide tools to monitor menstrual cycle symptoms. Notwithstanding intricate menstrual cycle dynamics, period and fertility tracking apps aim soundness and precision of predictions.	Dantas et al., 2022; Ford et al., 2021a; Gilman, 2021; Kressbach, 2021; Pichon et al., 2021
Fertility apps are typically in furtherance of purpose-oriented uses. Women can log days of menstrual cycle, descriptors of flow, and related signs and symptoms.	Figueiredo et al., 2021; French et al., 2020; Kressbach, 2021; Pichon et al., 2021
Fertility apps can support the standardization of fertility tracking as a pivotal component of everyday life. Apps designed for period tracking and ovulation prediction make dynamic cycle assessments according to incrementally input data but may have inaccuracies in content.	Favaro et al., 2021; Hamper, 2020; Mishra and Suresh, 2021; Zwingerman et al., 2020
Menstrual cycle tracking apps monitor users' periods and symptoms, predict ovulation and conception chances, and supply fertility data. Fluid and personalized algorithms that adjust to and assimilate knowledge from the individual user can increase the precision of predicting the fertile window during menstrual cycle tracking.	Blair et al., 2021; Kleinschmidt et al., 2019; Jennings et al., 2019; Kressbach, 2021

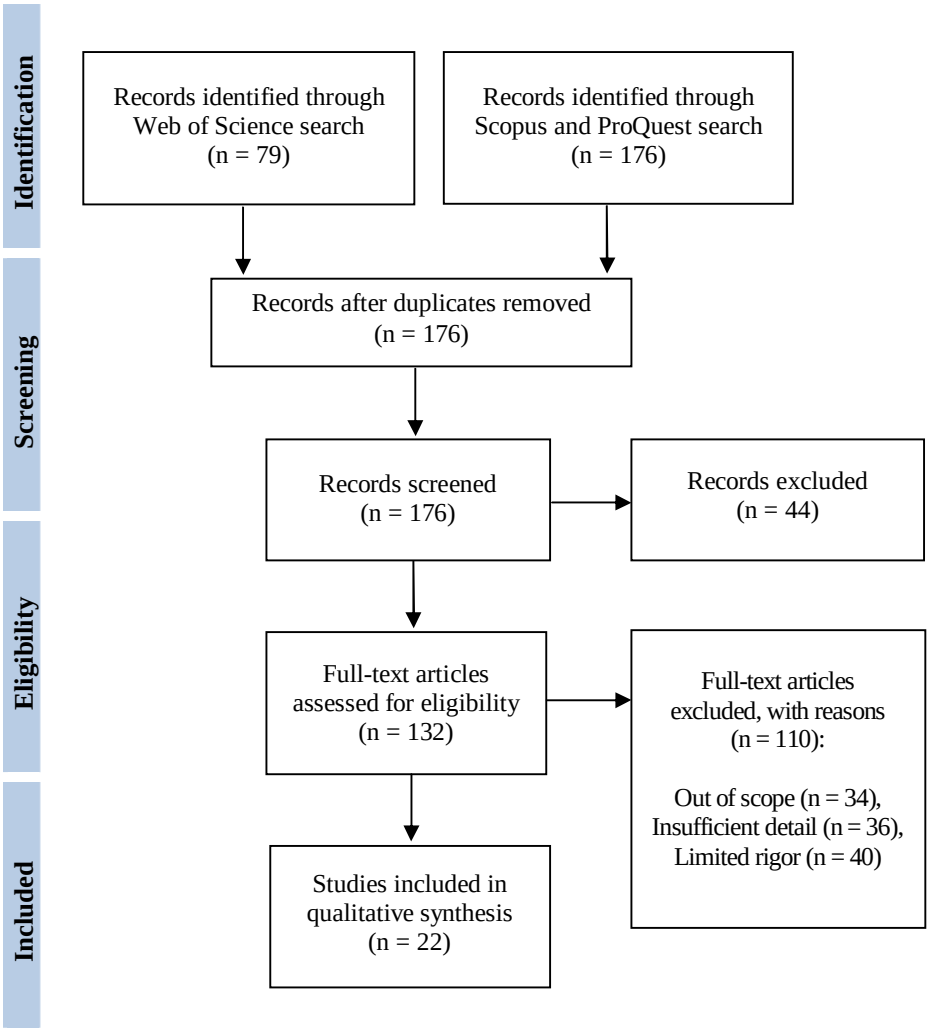


Figure 1 PRISMA flow diagram describing the search results and screening.

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used that ensure the literature review is comprehensive, transparent, and replicable. The flow diagram, produced by employing a Shiny app, presents the stream of evidence-based collected and processed data through the various steps of a systematic review, designing the amount of identified, included, and removed records, and the justifications for exclusions.
To ensure compliance with PRISMA guidelines, a citation software was used, and at each stage the inclusion or exclusion of articles was tracked by use of custom spreadsheet. Justification for the removal of ineligible articles was specified during the full-text screening and final selection.

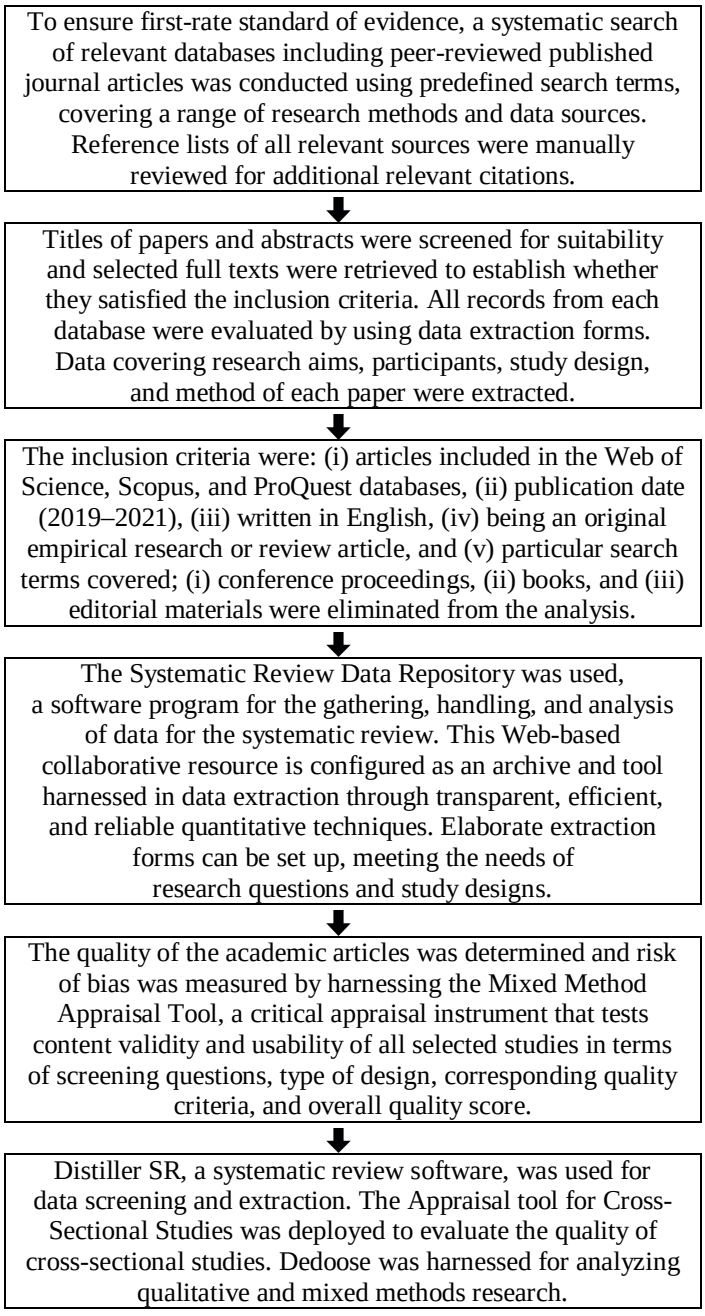


Figure 2 Screening and quality assessment tools

4. Period and Fertility Trackers as Digital Health Technologies

Digital fertility awareness-based birth control (Figueiredo et al., 2021; Hendl and Jansky, 2021; Kressbach, 2021; Pearson et al., 2021) provides a complementary option for women who do not plan to employ hormonal or invasive procedures. Fertility has been gradually furthered by consumer health technologies as mobile apps that assist self-tracking activities. The tracking characteristics of the log interface articulate private ways of monitoring symptoms and check and predict physiological excretion and excess. Period and fertility trackers as digital health technologies configure users' empowerment by use of robust data as regards their bodies, monitoring their procreative health.

App-based fertility tracking can be pivotal for the integrated transition (Ford et al., 2021a; Hamper, 2020; Johnson et al., 2020; Kressbach, 2021) from pregnancy prevention to purposefully enabling child-bearing, users' sense of self and personality, and their perception of the reproductive capacity of their bodies. The log's design can consolidate menstrual concealment and design life as influenced by menstrual processes. Users attempting to conceive are progressively harnessing fertility-tracking software apps to schedule intercourse. Female reproductive health apps focus on users who aim to track period-related health issues (e.g., hormone-triggered neuralgia or variable disposition).

By use of self-learning algorithms, menstrual cycle or period tracking apps enable women to monitor their periods and derive predictions (Earle et al., 2021; Johnson et al., 2020; Kressbach, 2021; Worsfold et al., 2021) as regards their period dates, ovulation day and the fertile window. Accurate and evidence-based menstrual and fertility app trackers in terms of fertility and reproductive health, pregnancy planning, and pregnancy prevention should be developed on clinical trials and user experience. By datafying the symptoms, digital menstruation and fertility trackers provide a precise and comprehensible manner of monitoring interrelationships between users' periods and their physical and psychological well-being. Female reproductive health apps may not be convenient for reliably timing intercourse. (Table 3)

Table 3 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Fertility has been gradually furthered by consumer health technologies as mobile apps that assist self-tracking activities.	Figueiredo et al., 2021; Hendl and Jansky, 2021; Kressbach, 2021; Pearson et al., 2021
Female reproductive health apps focus on users who aim to track period-related health issues	Ford et al., 2021a; Hamper, 2020; Johnson et al., 2020; Kressbach, 2021
By use of self-learning algorithms, menstrual cycle or period tracking apps enable women to monitor their periods and derive predictions.	Earle et al., 2021; Johnson et al., 2020; Kressbach, 2021; Worsfold et al., 2021

5. Fertility Tracking Apps for Personal Health Monitoring

Period tracking apps transfer to users health technologies (Bull et al., 2019; Figueiredo et al., 2021; Ford et al., 2021b; Kressbach, 2021) aiming self-scrutiny and self-care. Users' prearranged, predictable, and unintentional life phases, situations, and transitions shape how fertility apps assist their tracking behaviors. By use of the analytic sections of period and fertility tracking apps, women assimilate knowledge about themselves and can comprehend causal connections between their periods and experiences, clarifying their psychological and physical behaviors. Fertility tracking apps providing predictions as regards fertile days according exclusively to a demoded grasp of ovulation day inconsistency may entirely miss the fertile window.

Mobile apps advanced to monitor menstrual cycle and symptoms (Bull et al., 2019; de Paula Oliveira et al., 2021; Hamper, 2020; Kressbach, 2021) are fashionable for birth control purposes and fertility awareness. Fertility apps are considerably integrated in incessantly articulating fluid kinds of pre-pregnant embodiment. Period and fertility tracking apps fluctuate between attempting to empower women by use of self-analysis and strengthening the perception that menstrual cycles represent an unmanageable contemptible process that needs to be handled and suppressed. The large-scale harnessing of fertility tracking apps for personal health monitoring produces massive volumes of data regarding periods.

Knowledge is configured by converting the psychological, physical, and social routines of fertility tracking apps' users into data (Dantas et al., 2022; Ford et al., 2021a; Gilman, 2021; Kressbach, 2021; Pichon et al., 2021), and thus tracking and assessing their symptoms continuously. Basing fertile window algorithms on strict menstrual cycle duration and fluidity demands restricts the effectiveness of data provided to users. Period trackers are occasionally unreliable, resulting in unwanted pregnancies. mHealth apps for period tracking typically provide tools to monitor menstrual cycle symptoms. Notwithstanding intricate menstrual cycle dynamics, period and fertility tracking apps aim soundness and precision of predictions. (Table 4)

Table 4 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Period tracking apps transfer to users health technologies aiming self-scrutiny and self-care.	Bull et al., 2019; Figueiredo et al., 2021; Ford et al., 2021b; Kressbach, 2021
Mobile apps advanced to monitor menstrual cycle and symptoms are fashionable for birth control purposes and fertility awareness.	Bull et al., 2019; de Paula Oliveira et al., 2021; Hamper, 2020; Kressbach, 2021
mHealth apps for period tracking typically provide tools to monitor menstrual cycle symptoms.	Dantas et al., 2022; Ford et al., 2021a; Gilman, 2021; Kressbach, 2021; Pichon et al., 2021

6. Fertility Awareness Technologies and the Datafication of Menstruation

The datafication of menstruation attempts to reassure users in relation to the practicality of analytics-based patterns and interrelationships (Figueiredo et al., 2021; French et al., 2020; Kressbach, 2021; Pichon et al., 2021), but large-scale data analysis is needed as regards menstrual health conditions. Fertility awareness technologies can provide an inexpensive alternative for women planning to conceive in expectation of increased invasive investigations. Fertility apps are typically in furtherance of purpose-oriented uses. Women can log days of menstrual cycle, descriptors of flow, and related signs and symptoms.

Digital technologies and apps designed for handling fertility, menstrual cycles, and reproduction (Favaro et al., 2021; Hamper, 2020; Mishra and Suresh, 2021; Zwingerman et al., 2020) enhance user capacity for self-analysis but require robust intimate data. Fertility apps can support the standardization of fertility tracking as a pivotal component of everyday life, in terms of effortlessness, performance, and customization. Apps designed for period tracking and ovulation prediction make dynamic cycle assessments according to incrementally input data but may have inaccuracies in content. The upsides of deploying an app to assist conception include determination of the fertile days and, by harnessing ovulation detection algorithms, knowledge can be assimilated as regards a user's menstrual cycle.

Fluid and personalized algorithms that adjust to and assimilate knowledge from the individual user (Blair et al., 2021; Kleinschmidt et al., 2019; Jennings et al., 2019; Kressbach, 2021) can increase the precision of predicting the fertile window during menstrual cycle tracking. The sequence and insight characteristics of menstrual cycle and fertility apps may stimulate users to grasp their lives according to their menstrual cycles. Menstrual cycle tracking apps monitor users' periods and symptoms, predict ovulation and conception chances, and supply fertility data. Algorithm-based fertility apps can determine the fertile window of the period by using a user's menstrual cycle start date and can offer assistance on when to abstain from barebacking to prevent pregnancy. (Table 5)

Table 5 Synopsis of evidence as regards focus topics and descriptive outcomes (research findings)

Fertility apps are typically in furtherance of purpose-oriented uses.	Figueiredo et al., 2021; French et al., 2020; Kressbach, 2021; Pichon et al., 2021
Fertility apps can support the standardization of fertility tracking as a pivotal component of everyday life.	Favaro et al., 2021; Hamper, 2020; Mishra and Suresh, 2021; Zwingerman et al., 2020
Menstrual cycle tracking apps monitor users' periods and symptoms, predict ovulation and conception chances, and supply fertility data.	Blair et al., 2021; Kleinschmidt et al., 2019; Jennings et al., 2019; Kressbach, 2021

7. Discussion

I integrate our systematic review throughout research indicating how fertility has been gradually furthered by consumer health technologies as mobile apps that assist self-tracking activities. My research complements recent analyses clarifying how fertility apps can support the standardization of fertility tracking as a pivotal component of everyday life. I elucidate, by cumulative evidence, previous research demonstrating how menstrual cycle tracking apps monitor users' periods and symptoms, predict ovulation and conception chances, and supply fertility data.

8. Synopsis of the Main Research Outcomes

Algorithm-based fertility apps can determine the fertile window of the period by using a user's menstrual cycle start date. Period and fertility trackers as digital health technologies configure users' empowerment by use of robust data. Period and fertility tracking apps aim soundness and precision of predictions. Mobile apps advanced to monitor menstrual cycle and symptoms are fashionable for birth control purposes and fertility awareness.

9. Conclusions

Relevant research has investigated whether, by use of self-learning algorithms, menstrual cycle or period tracking apps enable women to monitor their periods and derive predictions. This systematic literature review presents the published peer-reviewed sources covering accurate and evidence-based menstrual and fertility app trackers in terms of fertility and reproductive health, pregnancy planning, and pregnancy prevention. The research outcomes drawn from the above analyses indicate the relevance of the psychological, physical, and social routines of fertility tracking apps' users in terms of how digital menstruation and fertility trackers can datafy symptoms.

10. Limitations, Implications, and Further Directions of Research

By analyzing only articles published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2018 and 2021, relevant sources on the datafication of fertility and reproductive health in terms of menstrual cycle tracking apps and ovulation detection algorithms may have been excluded. Limitations of this research comprise particular kinds of publications (original empirical research and review articles), discounting others (conference proceedings articles, books, and editorial materials). The scope of my study also does not move forward the inspection of the large-scale harnessing of fertility tracking apps for personal health monitoring.

Subsequent analyses should develop on cutting-edge digital technologies and apps designed for handling fertility, menstrual cycles, and reproduction. Future research should thus investigate fertility tracking apps providing predictions as regards fertile days. Attention should be directed to the precision of predicting the fertile window during menstrual cycle tracking.


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The author confirms being the sole contributor of this work and approved it for publication. The author takes full responsibility for the accuracy and the integrity of the data analysis.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Transparency statement
The author affirms that the manuscript represents an honest, accurate, and transparent account of the research being reported, that no relevant aspects of the study have been left out, and that any inconsistencies from the research as planned (and, if significant, registered) have been clarified.

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