DOI: https://doi.org/10.30841/2708-8731.8.2025.349095
UDC 618.1-055.2:159.9:378:314.4:004.9

Reproductive competence of female students: an interdisciplinary framework for health, education, and demographic sustainability

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Women's reproductive health in the 21st century is influenced by demographic transitions, psycho-emotional stressors, and digital transformations in higher education. Despite progress in sexual and reproductive health and rights, substantial gaps remain in female students' knowledge, access to services, and responsible decision-making.
The objective: **to conceptualize the phenomenon of reproductive competence of female students as a multidimensional construct that integrates cognitive, bodily, emotional, social, and digital dimensions.**
Materials and methods**. A mixed design was used: a three-round Delphi survey with 100 experts (sexual and reproductive health and rights, psychology, pedagogy, demography) and a cross-sectional online survey among 1,216 female students (18–29 years, seven Ukrainian universities). The authorial questionnaire included 30 items across five components and the 4-item Perceived Stress Scale (PSS-4). Reliability was confirmed using Cronbach's α and McDonald's ω (range 0.79–0.82), and construct validity was supported. Data analysis involved descriptive statistics, Spearman's correlations, and Mann–Whitney U tests.**
Results**. The Delphi panel confirmed the relevance of all components, prioritizing cognitive, social, and digital ones for higher education. The student survey revealed knowledge gaps (52.8% of persons identified risks of delayed motherhood), bodily and emotional vulnerabilities (63.5% – dysmenorrheal, 58.9% – high stress), barriers due to stigma (32.0% persons avoided services), and ambivalence in digital use (71.1% of students used apps, but only 34.6% of students critically assessed sources).**
Conclusions**. Reproductive competence consists of cognitive, physical, emotional, social and digital components and acts as an individual resource of resilience and an institutional framework of support for female students. Universities are identified as key agents in fostering reproductive literacy, psycho-educational programs, digital hygiene, and stigma reduction, with implications for women's health and demographic sustainability.**
Keywords: *reproductive competence, female students, reproductive health literacy, digital health, psycho-educational support, demographic resilience.*

Репродуктивна компетентність студенток: міждисциплінарна рамка для здоров'я, освіти та демографічної стійкості

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Репродуктивне здоров'я жінок у XXI ст. визначається демографічними змінами, психоемоційними навантаженнями та цифровими трансформаціями вищої освіти. Попри досягнення у сфері сексуального та репродуктивного здоров'я і прав, значні прогалини зберігаються в знаннях студенток, доступі до послуг та готовності ухвалювати відповідальні рішення.
Мета дослідження: здійснити концептуалізацію феномену репродуктивної компетентності студенток як багатовимірної категорії, що інтегрує когнітивний, тілесний, емоційний, соціальний і цифровий виміри.
Матеріали та методи. Використано змішаний дизайн: трираундове Delphi-опитування 100 експертів (сексуальне й репродуктивне здоров'я та права, психологія, педагогіка, демографія) та онлайн-анкетування 1216 студенток віком 18–29 років із семи університетів України. Авторська анкета включала 30 питань за п'ятьма компонентами та шкалу сприйнятого стресу PSS-4 (Perceived Stress Scale). Надійність підтверджено за допомогою коефіцієнтів α Кронбаха та ω МакДональда (у межах 0,79–0,82), що засвідчує внутрішню узгодженість шкал. Статистичний аналіз охоплював описову статистику, кореляції Спірмена та U-критерій Манна – Уїтні.
Результати. Delphi-панель підтвердила значущість усіх компонентів, особливо когнітивного, соціального та цифрового. Опитування студенток виявило суттєві прогалини у знаннях (52,8% визначають ризики відкладеного материнства), тілесні й емоційні вразливості (63,5% – дисменорея, 58,9% – високий рівень стресу), бар'єри стигми (32,0% уникають звернення до сервісів) та амбівалентність цифрового виміру (71,1% користуються мобільними додатками, але лише 34,6% критично оцінюють джерела).
Висновки. Репродуктивна компетентність складається з когнітивного, тілесного, емоційного, соціального й цифрового компонентів та виступає як індивідуальний ресурс стійкості та інституційна рамка підтримки студенток. Університети визначаються ключовими агентами її формування через інтеграцію курсів репродуктивної грамотності, психоосвітніх програм, цифрової гігієни та антистигматизаційних заходів, що має значення для здоров'я жінок і демографічної стійкості.
Ключові слова: *репродуктивна компетентність, студентки, репродуктивна грамотність, цифрове здоров'я, психоосвітня підтримка, демографічна стійкість.*

In the 21st century, women's reproductive health is shaped at the intersection of global demographic trends, psychological factors, and the digital transformation of the educational environment. Despite substantial progress in sexual and reproductive health and rights (SRHR), as outlined by the Guttmacher-Lancet Commission, significant gaps persist in access, quality of services, and outcomes-particularly for young women and female students transitioning into adulthood under conditions of uncertainty and information overload [1]. Global demographic estimates (GBD 2019) indicate a steady decline in fertility and population aging, accompanied by heterogeneous trends in maternal mortality, creating long-term challenges for demographic resilience in Europe and Ukraine alike [2]. The historical dynamics of maternal mortality (1990–2015) reveal uneven progress (≈ 44% global reduction), underscoring the need for more systemic multisectoral interventions beyond purely biomedical approaches [3, 4].

A key driver of improved outcomes is modern family planning: global analyses confirm that expanded access to modern contraceptives reduces unmet need, yet regional and socioeconomic disparities remain. Between 2015–2019, approximately 121 million unintended pregnancies were recorded annually, 61% of which ended in abortion [5–7]. The COVID-19 pandemic added further strain: meta-analyses demonstrated increases in maternal mortality and stillbirths, particularly in low-resource settings, although many countries avoided the worst-case scenarios in family planning due to institutional resilience and compensatory measures [8, 9]. Armed conflicts and humanitarian crises pose additional risks to SRHR by reducing access and continuity of services, amplifying indirect causes of mortality, and exacerbating mental health burdens among women of reproductive age [10].

The Ukrainian context combines long-standing disparities in reproductive health indicators with the new challenges of wartime conditions. Pre-war studies already documented relatively lower levels of women's reproductive health compared with Western Europe and highlighted the need for systemic reforms [11]. Since 2022, nationwide cross-sectional surveys confirm high levels of stress, anxiety, and post-traumatic stress disorder symptoms among the population-especially women and displaced persons-which directly and indirectly affect reproductive behaviors and pregnancy outcomes [12]. Simultaneously, digital behavior among Ukrainians reflects heightened demand for information on contraception, pregnancy tests, ovulation, and sexual violence-serving as indicators of "hidden" needs during crisis periods and signaling the necessity of targeted support services [13]. Recent interdisciplinary research in Ukrainian journals emphasizes the interconnection between psycho-emotional distress, menstrual cycle disruptions, and reproductive risks among women during wartime, and outlines models of psychological safety and support that are highly relevant for educational institutions [14, 15].

Within this multifactorial landscape, female students represent a strategic yet vulnerable group for demographic policy. Their profile is marked by intensive academic and digital engagement, heightened informational exposure, the formation of long-term life and reproductive intentions, and sensitivity to academic stress and environmental conditions. International reviews highlight persistent gaps in knowledge about fertility, reproductive life planning, and health-preserving behaviors, while demonstrating that educational interventions, digital tools, and reproductive/health literacy initiatives can enhance awareness, intention-setting, and service uptake-particularly when tailored to context and youth autonomy [16–19]. However, digitalization also introduces new risks: informational overload, anxiety, normalization of poor-quality sources, and body-dysmorphic narratives, all of which may shape decisions about contraception, help-seeking, and the postponement of parenthood for non-financial, emotionally driven reasons. Practices of digital SRHR support within youth services (particularly in Europe) show both promise and barriers to implementation, which should be considered in university policies [20].

Although SRHR discourse is saturated with terms such as *reproductive literacy*, *reproductive autonomy*, and *sexual competence*, there remains a lack of an integrative category encompassing the cognitive, emotional, behavioral, social, and digital dimensions of young women's capacity to consciously maintain and regulate reproductive health amid contemporary challenges. This article introduces and conceptualizes the term *"reproductive competence"*, defined as the multidimensional ability of female students to make informed, ethically responsible, and psychologically resilient decisions regarding reproductive health. It integrates knowledge, bodily awareness, emotional self-regulation, digital hygiene, social interaction, and autonomy in seeking care. Importantly, such competence is shaped (or undermined) within the university ecosystem-through curricula, mentorship, caring practices, accessible digital services, and intersectoral collaboration with healthcare. Building on an interdisciplinary framework, the study develops a model that positions reproductive competence not only as a foundation for psycho-educational support within higher education but also as a critical determinant of women's health and demographic sustainability. The framework highlights the role of universities as agents of demographic stability, capable of fostering digital care practices, reproductive literacy, and psycho-emotional resilience in the context of war, post-COVID challenges, and global demographic transitions.

The objective of this study is to conceptualize reproductive competence of female students as a multidimensional construct that integrates cognitive, physical, emotional, social, and digital dimensions.

MATERIALS AND METHODS

Study design. At the conceptual level, the study refined and systematized key theoretical categories and definitions based on contemporary interdisciplinary discourse. This provided the rationale for introducing the construct of "reproductive competence".

Delphi study. To refine the conceptual model, a three-round Delphi survey was administered to an expert panel (n = 100). The panel included:

- 22 SRHR specialists (obstetrician-gynecologists, family doctors);
- 28 psychologists/psychotherapists with expertise in youth and crisis counseling;

ISSN 2708-8723 (print)
ISSN 2708-8731 (online)

– 26 representatives of university structures (deans, student well-being services, mentoring programs);
– 24 researchers in demography and public policy.

Experts represented nine Ukrainian universities and eight healthcare institutions, with a mean professional experience of 14.3 ± 6.1 years. In round one, participants provided open-ended responses; in round two, they evaluated the importance and feasibility of proposed components and interventions using a 9-point Likert scale; in round three, consensus was verified. Consensus was defined as a median ≥ 7 and an interquartile range ≤ 2. Data were analyzed using IBM SPSS Statistics 27 and Microsoft Excel; qualitative responses were coded thematically following framework [5] (Appendix A).

Student survey. At the empirical stage, an original questionnaire was administered among 1,216 female students aged 18–29 years from seven Ukrainian universities of diverse profiles (Dnipro Technological University "STEP", Oles Honchar Dnipro National University, National University Zaporizhzhia Polytechnic, Zaporizhzhia National University, Classic Private University, Khortytsia National Educational and Rehabilitational Academy of Zaporizhzhia Regional Council, and Zaporizhzhia Medical University).

Inclusion criteria: enrollment at a university, female gender, informed consent. Exclusion criteria: absence of consent, duplicate submissions. A stratified random sampling procedure was applied across years of study. Data were collected online via Google Forms between May – June 2025. Participation was voluntary, anonymous, and students were able to skip any question.

The instrument contained 30 items grouped into five components: cognitive, bodily, emotional, social, and digital. Most items used a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) (Appendix B). Inverse statements were included to minimize social desirability bias. Behavioral items assessed gynecological check-ups, contraceptive use, and access to reproductive health services. Two open-ended questions allowed qualitative insights. The questionnaire was grounded in the authorial model of reproductive competence and adapted from validated international instruments.

The student questionnaire additionally incorporated the 4-item Perceived Stress Scale (PSS-4), which assesses perceived stress during the last month [21]. Responses were recorded on a 5-point Likert scale (0 = never, 4 = very often), with higher scores indicating greater stress. Scores were interpreted according to established cut-offs: 0–4 – low stress, 5–8 – moderate stress, 9–16 – high stress. Internal consistency of the PSS-4 in our sample was acceptable (Cronbach's $\alpha = 0.79$).

Validation. The tool was adapted via a translation–back translation procedure. Internal consistency was confirmed with Cronbach's α: PSS-4 ($\alpha = 0.79$), Digital Well-being Index ($\alpha = 0.82$). In line with recent Ukrainian validation studies of screening instruments [22], the authorial questionnaire was embedded in the broader context of psychometric adaptation for reproductive health research. A complete matrix "component → indicators → items → sources" documented the correspondence of items to theoretical constructs.

Data analysis. For the Delphi study, descriptive statistics (median, interquartile range) were calculated. For the student survey, descriptive, correlation, and comparative analyses were conducted. Associations between reproductive competence components were tested using Spearman's correlation ($p < 0.05$). Group comparisons by year of study and demographic characteristics were performed with the Mann–Whitney U test.

Delphi Questionnaire (Appendix A). Round 1 (open-ended): collection of authorial definitions, proposals for subcomponents and indicators; listing of barriers and potential interventions within universities. **Round 2 (ratings 1-9):** assessment of the importance/relevance of each element; written comments for refinement of wording. **Round 3 (consensus):** re-evaluation with provision of group medians / interquartile ranges; consensus defined as interquartile range ≤ 2.

Sample items:

1. "Inclusion of digital hygiene into the model is critically necessary" (1–9).
2. "List three indicators of the cognitive component suitable for screening in higher education institutions" (open-ended).
3. "Prioritize interventions: fertility course; mentoring; digital services; access to SRHR clinics; anti-stigmatization campaigns" (ranking).

Student Questionnaire (12–15 min, online) (Appendix B). *Sections and sample items (5-point Likert scale unless otherwise specified):*

- **Cognitive:** "I understand how age/stress affects fertility"; "I can choose a contraceptive method considering contraindications".
- **Bodily:** "I track my cycle/symptoms and know when to see a doctor"; "Over the last year, my cycle has become more irregular (yes/no)".
- **Emotional:** "I use techniques to reduce anxiety during academic load"; "I feel emotionally drained after prolonged online consumption".
- **Social:** "I feel comfortable contacting university SRHR services/mentor"; "I know where to access anonymous counseling".
- **Digital:** "I can distinguish reliable medical sources from blogs/advertising"; "I use verified apps/telemedicine".
- **Behavioral outcomes:** last gynecological visit; use of modern contraception; action plan in case of unintended pregnancy.
- **War/access context:** displacement, interruptions in access to services; online search activity on SRHR topics [13].

Item development followed the mapping of indicators across five components; content validity was ensured through the Delphi procedure.

Data collection procedures. Delphi – three online rounds with 2–3 week intervals; individual anonymous participation; personalized invitations and reminders. Student survey – online anonymous format; dissemination via university channels and course groups; control of single submission (unique link / captcha / timestamp).

Psychometric and statistical processing.

Pilot testing: student questionnaire (n ≈ 80–100) for cognitive pre-testing and refinement of wording.

Reliability: Cronbach's α / McDonald's ω for subscales (target ≥ 0.70).

Validity: EFA (oblimin), followed by CFA (CFI/TLI ≥ 0.90; RMSEA ≤ 0.08) (EFA – Exploratory Factor Analysis; CFA – Confirmatory Factor Analysis; CFI – Comparative Fit Index; TLI – Tucker-Lewis Index; RMSEA – Root Mean Square Error of Approximation).

Measurement invariance: tested across subgroups (year of study / faculty / residence type) where feasible.

Associative analysis: correlations among components; multiple regression / SEM (Structural Equation Modeling) to examine pathways (digital and emotional – cognitive/behavioral); subgroup comparisons (displaced vs non-displaced; active vs non-active SRHR service users).

Delphi consensus: median and interquartile range; consensus threshold at interquartile range ≤ 2; assessment of stability across rounds.

Ethical considerations. The study was approved by the Ethics Committee of the Institute for the Development of Practical Psychology (Zaporizhzhia), Protocol No. 4, 07 April 2025. Informed consent was obtained from all participants. Ethical principles of anonymity, confidentiality, voluntariness, and the right to withdraw were strictly respected in accordance with the Declaration of Helsinki. Sensitive items were minimized, and participants were provided with a list of SRHR and psychological support services at the end of the survey.

Data management and transparency. Primary data and analytic code are stored in an encrypted institutional repository, accessible only to the authorial team. Anonymized matrices and specifications of the instrument are available upon request to reviewers. Reporting adheres to best practices for survey-based research, adapted to the requirements of the journal.

Methodological rationale. The Delphi technique ensured interdisciplinary consensus regarding the novel construct and indicators of reproductive competence in the SRHR domain, where determinants extend beyond biomedicine [1, 4]. The student survey (n = 1,216) provided adequate statistical power for confirmatory factor analysis and for testing associations with digital well-being, stress, and behavioral indicators of service use and contraceptive practices.

RESULTS AND DISCUSSION

Terminological field and theoretical foundations.

In contemporary academic discourse, women's reproductive health is conceptualized through adjacent categories such as reproductive literacy, reproductive autonomy, and sexual competence. *Reproductive literacy* is defined as the level of knowledge and skills necessary for informed choices in the field of reproductive health [16]. *Reproductive autonomy* emphasizes a woman's ability to control her reproductive decisions, including access to contraception and safe abortion [6, 23]. *Sexual competence* describes the ability to engage in responsible sexual behavior, combining knowledge, emotional maturity, and social norms [17]. Global reports stress the need to integrate these dimensions into more holistic frameworks, given that reproductive outcomes are shaped not only by individual awareness but also by social determinants, service accessibility, and digital environments [1, 4, 24, 25].

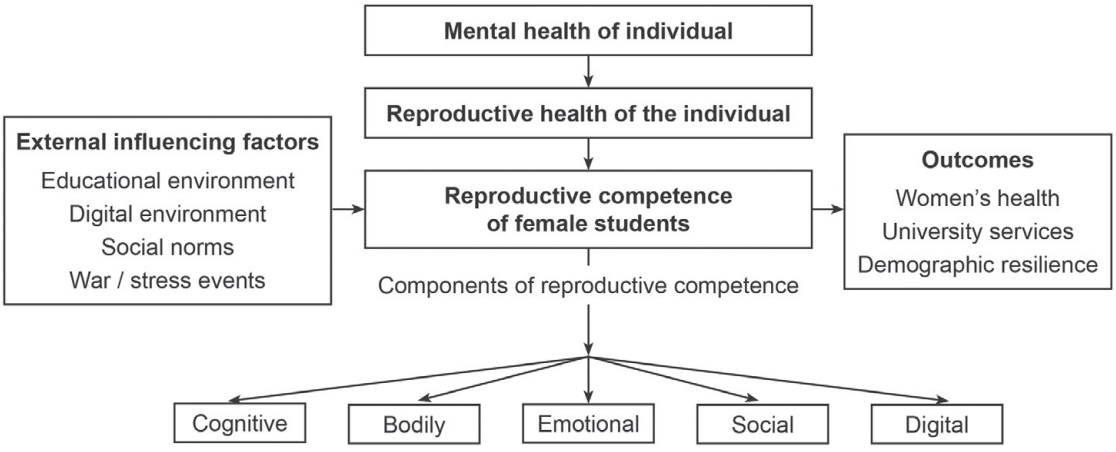
Definition of reproductive competence.

We define reproductive competence as a multidimensional capacity to make informed, ethically responsible, and psychologically resilient decisions about one's reproductive health. It integrates cognitive knowledge, bodily awareness, emotional self-regulation, social skills, and digital literacy. Its development is conditioned by socioeconomic factors [26, 27], demographic trends [2, 3], and institutional health policies [11].

For female students, reproductive competence acquires specific contours shaped by the university environment. It includes:

- Cognitive dimension – knowledge about fertility, contraception, and risks of delayed motherhood [18].
- Bodily dimension – awareness of physiological changes, self-care, and prevention [14].
- Emotional dimension – stress resilience and psycho-emotional balance [12].
- Social dimension – communication, stigma reduction, institutional support [28, 29].
- Digital dimension – digital hygiene, critical use of online resources and apps [30, 31].

As shown in Figure, the hierarchical model of reproductive competence of female students integrates five core



Hierarchical model of reproductive competence of female students

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ISSN 2708-8723 (print)
ISSN 2708-8731 (online)

dimensions – cognitive, bodily, emotional, social, and digital, positioned within an interdisciplinary framework that links individual resilience with institutional and demographic sustainability.

Empirical findings.

Expert Delphi Survey (n = 100). Consensus was reached on the importance of all five components of reproductive competence (median = 8–9; interquartile range ≤ 2). However, cognitive, social, and digital dimensions were considered the most realistic for integration into higher education, while bodily and emotional components were judged as critical yet resource-intensive.

Student Survey (n = 1,216; seven universities).

Cognitive dimension. Out of 1,216 respondents, 642 (52.8%) correctly identified the risks of delayed motherhood, 381 (31.3%) provided partially correct or incomplete answers, and 193 (15.9%) selected incorrect or "don't know" responses. Regarding contraceptive knowledge, 575 students (47.3%) confidently named at least one modern contraceptive method, 312 (25.7%) demonstrated partial knowledge (naming traditional or outdated methods), and 329 (27.0%) were unable to identify any method. Similar knowledge gaps are reported among female students in Poland and China [16, 17, 31, 32].

Bodily dimension. A total of 772 respondents (63.5%) reported regular dysmenorrhea, 291 (23.9%) experienced it occasionally, and 153 (12.6%) indicated no menstrual pain. Concerning academic impact, 507 students (41.7%) reported that dysmenorrhea significantly affected their academic performance, 436 (35.9%) noted occasional impact, while 273 (22.4%) reported no effect. These findings align with evidence from Ethiopia and China [33, 34] and with Ukrainian clinical data during wartime [14].

Emotional dimension. According to the PSS-4, 717 students (58.9%) scored in the high stress category, 362 (29.8%) in the moderate range, and 137 (11.3%) in the low range. Thus, nearly 9 out of 10 respondents reported at least moderate stress, confirming the psycho-emotional vulnerability of the student population. Stress-related reproductive risks were also documented in large-scale Ukrainian surveys [12] and international studies on exam stress and menstrual dysfunction [35].

Social dimension. Of all participants, 389 (32.0%) reported avoiding university or medical SRHR services due to stigma, 641 (52.7%) indicated they accessed such services without difficulty, and 186 (15.3%) expressed uncertainty or had no relevant experience. This barrier corresponds to findings in Serbia [36] and Poland [16].

Digital dimension. A majority of 865 respondents (71.1%) reported using menstrual tracking applications, while 351 (28.9%) did not use them. Among users, only 421 students (34.6% of the total sample) critically evaluated the reliability of online health sources, whereas 795 (65.4%) did not apply any form of critical assessment. Comparable trends have been identified in Sweden and the USA [19, 31, 37]. These comprehensive findings demonstrate asymmetry between strong digital engagement and persistent gaps in cognitive and bodily literacy, coupled with psycho-emotional vulnerability and stigma-related barriers in the social dimension.

A structured summary of the empirical findings and their international parallels is presented in Table, which highlights the fragmented cognitive knowledge, the vulnerability of physical and emotional dimensions, the constraining role of stigma in the social domain, the pivotal nature of the digital component, and the direct linkage between reproductive competence and demographic resilience.

The results of this study demonstrate that reproductive competence among Ukrainian female students is characterized by marked asymmetry between high levels

Key findings on reproductive competence of female students (n = 1,216)

Findings	Evidence (absolute and relative values)	Implications
Cognitive dimension of students' knowledge is fragmented	642 (52.8%) correctly identified risks of delayed motherhood; 381 (31.3%) partially correct; 193 (15.9%) incorrect / "don't know". Regarding contraceptives: 575 (47.3%) named modern methods; 312 (25.7%) partially correct; 329 (27.0%) no knowledge	Need for integration of basic courses on reproductive literacy into higher education
Physical and emotional components are the most vulnerable	Dysmenorrhea: 772 (63.5%) regular; 291 (23.9%) occasional; 153 (12.6%) absent. Academic impact: 507 (41.7%) significant; 436 (35.9%) occasional; 273 (22.4%) no impact. Stress (PSS-4): 717 (58.9%) high; 362 (29.8%) moderate; 137 (11.3%) low	Necessity of psycho-emotional support programs and body awareness training for female students
The social component is constrained by stigma	389 (32.0%) avoided services due to stigma; 641 (52.7%) accessed services without barriers; 186 (15.3%) uncertain / no experience	Urgent need for anti-stigmatization campaigns and the development of psychological/medical support services in universities
The digital component is becoming pivotal	865 (71.1%) used menstrual tracking apps; 351 (28.9%) did not. Critical evaluation of sources: 421 (34.6%) yes; 795 (65.4%) no	Formation of "digital health literacy" as an integral part of educational programs
Reproductive competence is directly linked to demographic resilience	Under war/migration: 1,216 students reported heightened anxiety and reproductive uncertainty. Analogous findings reported in Cameroon, Uganda, Ethiopia	Institutionalization of reproductive competence as a component of educational and demographic policy
Universities as agents of demographic stability	Conceptual parallels with the theory of the second demographic transition [38, 39]	Higher education institutions may serve as platforms for shaping a culture of women's health and preventive demographic policy

ISSN 2708-8723 (print)
ISSN 2708-8731 (online)

of digital engagement and persistent gaps in cognitive and bodily dimensions. For example, while 71.2% of respondents reported active use of mobile applications for menstrual tracking, only 34.6% were able to critically evaluate the reliability of digital sources. This finding echoes recent evaluations of menstrual health applications, which highlight insufficient health education content and inclusivity despite their popularity among young users [31]. The gap between usage and literacy underscores the need for higher education institutions to position themselves as mediators of digital health literacy, integrating critical assessment skills into broader reproductive health education programs.

The high prevalence of dysmenorrheal (63.5%) and stress-related symptoms (58.9%) reported by participants aligns with global evidence linking psycho-emotional load to menstrual cycle irregularities and academic performance [33, 34, 40]. Importantly, these data reveal a dual vulnerability: reproductive health outcomes are undermined simultaneously by physical discomfort and stress-driven cognitive overload. The findings correspond with the broader literature emphasizing that student well-being and reproductive autonomy cannot be addressed without integrated stress-reduction and bodily-awareness programs [41, 42].

Equally critical is the social dimension: 32% of respondents reported avoiding university or medical services due to stigma. Comparable barriers have been identified in diverse cultural contexts, including Sub-Saharan Africa and the Middle East, where stigma and institutional neglect restrict access to reproductive health services [43, 44]. These convergent findings suggest that stigma operates as a structural determinant, cutting across cultural and geopolitical settings. For Ukraine, this emphasizes the urgency of embedding anti-stigmatization campaigns into university policy, supported by partnerships with civil society organizations and student-led initiatives.

Finally, the study contributes to demographic research by illustrating that reproductive competence functions as a strategic predictor of resilience during crises. Elevated levels of anxiety and reproductive uncertainty among displaced students mirror similar dynamics observed in war-affected regions such as Cameroon and Ethiopia, where conflict exacerbates unmet reproductive health needs and delays in childbearing intentions [45, 46]. Within this perspective, reproductive competence emerges not only as an individual-level construct but also as a population-level resource, aligning with recent demographic analyses that frame universities as agents of societal stability [47, 48].

The empirical findings demonstrate that reproductive competence among Ukrainian female students is fragmented, with clear vulnerabilities in bodily and emotional health, and structural barriers in social and digital domains. These results resonate with both Ukrainian and international evidence:

– Ukrainian context. National studies confirm high prevalence of stress, menstrual cycle disorders, and reproductive risks among women during wartime [14]. Increased anxiety and post-traumatic stress disorder symptoms among displaced populations disproportionately affect women of reproductive age [12].
– International parallels. Similar gaps in knowledge and access to SRHR services are documented among students in Cameroon [33, 43], and Bangladesh [49]. Digital literacy remains a universal challenge: while students worldwide use health apps, their ability to filter evidence-based content is limited [31, 50].

Digital dimension and psycho-educational support. Particular attention should be paid to the Ukrainian contribution to the development of the concept of digital care as a component of psycho-educational support. O. Cherepiekhina argues that a digital culture of care can be integrated into educational institutions as a tool of psychological safety and a resource for demographic resilience. This highlights the need to combine digital innovations with psycho-emotional support, especially in times of crisis [20].

Policy relevance. Stigmatization and avoidance of institutional services, confirmed in this study (32.0%), mirror barriers identified in Serbia and Uganda [30, 36]. Universities thus emerge as pivotal agents for anti-stigma initiatives and digital health promotion, consistent with the "health-promoting universities" model [37]. These findings are consistent with Ukrainian and international evidence emphasizing the role of communication and lifestyle models in shaping health behaviors among youth [23, 24]. In particular, recent analyses highlight how national and international strategies for healthy lifestyle promotion among young people can inform reproductive health education and stigma-reduction campaigns [25].

Demographic resilience. The Ukrainian case exemplifies the second demographic transition [39, 50], where delayed motherhood and declining fertility intersect with conflict-related uncertainties [51]. Reproductive competence should therefore be institutionalized as both a preventive health measure and a demographic policy instrument [48].

CONCLUSIONS

This study has conceptualized reproductive competence of female students as a multidimensional construct that integrates cognitive, bodily, emotional, social, and digital dimensions. Expert consensus obtained through the Delphi procedure confirmed the validity of all five components, highlighting the cognitive, social, and digital domains as the most feasible for integration into higher education.

The student survey (n = 1,216) revealed critical asymmetries: limited knowledge of fertility and contraception, high prevalence of dysmenorrhea and stress, persistent stigma in seeking support, and insufficient digital health literacy despite widespread use of menstrual tracking applications. These findings confirm that reproductive competence is simultaneously strengthened and undermined by diverse factors within the university environment.

Universities play a pivotal role in fostering reproductive competence by integrating health literacy, psycho-

ISSN 2708-8723 (print)
ISSN 2708-8731 (online)

educational support, digital hygiene, and stigma-reduction initiatives, thereby strengthening resilience and promoting responsible reproductive behavior among young women. At the societal level, reproductive competence emerges as a key factor of demographic sustainability, with the Ukrainian case offering transferable insights for countries facing similar challenges of low fertility, delayed motherhood, and psychosocial uncertainty.

Limitations and future directions. This study is limited by reliance on self-reported data, the absence of biomedical indicators, and sample representation from only seven universities. Future research should expand to more diverse populations and integrate psychophysiological measures to refine the bodily and emotional dimensions.

Conflict of interest. The authors declare no conflicts of interest.

Appendix A

Methodological appendix: Delphi analysis framework

Expert Questionnaire for the Delphi Survey

Topic: Reproductive Competence of Female Students: An Interdisciplinary Framework for Psycho-Pedagogical Support in the Context of Global Demographic Resilience

The Objective of the Delphi Survey

To achieve expert consensus regarding:

1. The definition of reproductive competence.
2. Its key components and indicators.
3. Educational and social interventions for fostering this competence in higher education.

Instructions

– Please evaluate each statement on a **1–9 scale**:
  • 1–3 = low importance / do not support;
  • 4–6 = moderate importance / requires clarification;
  • 7–9 = high importance / fully support.
– Some items include fields for open-ended responses.
– The survey is conducted in multiple rounds. In subsequent rounds, you will be provided with a summary of group results and may, if desired, revise your ratings.

Round 1. Generating Core Ideas

Block 1. Definition of the Concept

1. Evaluate the importance of including the following aspects in the definition of reproductive competence:
   – Knowledge and awareness;
   – Bodily self-awareness;
   – Emotional resilience;
   – Social support;
   – Digital hygiene.
   (1–9 for each; with comments)
2. Which of the following formulations best reflects your perspective?
   a) Reproductive competence as a knowledge-based competence (primarily cognitive).
   b) Reproductive competence as an integrated personal characteristic (cognitive + emotional + social).
   c) Reproductive competence as a socio-behavioral construct linked to demographic and educational policy.
   (1–9 for each; with comments)
3. Provide your own definition of reproductive competence.
   (open-ended)

Block 2. Components and Indicators

4. Evaluate the importance of each component:
   – Cognitive (knowledge, understanding);
   – Bodily (self-monitoring, healthy practices);
   – Emotional (stress resilience, self-regulation);
   – Social (help-seeking capacity, support networks);
   – Digital (digital hygiene, use of reliable resources).
   (1–9 for each; with comments)
5. Which 3–5 indicators do you consider most appropriate for measuring each component?
   (open-ended)

Block 3. Interventions in Higher Education

6. Evaluate the importance of the following interventions:
   – Courses on the basics of reproductive health;
   – Programs on emotional literacy and stress resilience;
   – Use of digital support services for female students;
   – University clinics/health centers;
   – Anti-stigmatization information campaigns.
   (1–9 for each)
7. Assess the feasibility of implementing these interventions in Ukrainian universities.
   (1–9 for each; with comments)
8. What barriers, in your opinion, may limit the implementation of these measures?
   (open-ended; examples: cultural stereotypes, resource limitations, insufficient staff training)
9. What three key arguments would you present to convince higher education and health sector policymakers of the importance of developing reproductive competence among female students?
   (open-ended)

Block 4. Policy and Strategic Dimension

10. Should the concept of reproductive competence be integrated into national health strategies and demographic policies?
    (1–9; with comments)

Rounds 2 and 3 (Summary)

– **Round 2:** Experts will receive a consolidated list of indicators and interventions (collected from **Round 1**) to evaluate on a 1–9 scale.
– **Round 3:** Re-evaluation will be conducted with group medians and interquartile ranges provided; consensus will be defined as an interquartile range ≤ 2.

Key Improvements in the Revised Version
- Alternative definitions are included to avoid leading participants.
- A balance of open- and closed-ended questions has been ensured.
- Instructions for the 1–9 scale have been clarified.
- Questions are phrased neutrally ("evaluate the importance..." rather than "this is key...").
- Interventions are assessed separately for **importance** and **feasibility**.
- Barriers and arguments remain open-ended but allow for later structuring.

Instrument for Processing Delphi Results
1. Quantitative Processing (1–9 scale)
Formulas:
- **Median (Me):** central value of the distribution;
- **Interquartile Range (IQR):** Q3–Q1 (difference between the 75th and 25th percentile);
- **Consensus:** considered achieved if IQR ≤ 2 and Me ≥ 7.

Example Table (Block "Components"):

Components	N	Me	Q1	Q3	IQR	Consensus	Expert Comments
Cognitive	100	8	7	9	2	Yes	"Critically important for female students"
Bodily	100	7	6	8	2	Yes	"Important but culturally dependent"
Emotional	100	9	8	9	1	Yes	"Without this, the resource is lost"
Social	100	6	4	7	3	No	"Not always prioritized in universities"
Digital	100	7	6	8	2	Yes	"Essential due to fakes and online dependence"

2. Qualitative Processing (Open-Ended Questions)
Algorithm:
1. **Coding of responses:** identification of semantic categories (e.g., "barriers" – cultural, resource, institutional).
2. **Frequency analysis:** count the number of mentions of each category.
3. **Summarization:** include categories with ≥ 20% mentions in **Round 2.**
4. **Example:**
   - Open-ended question: "What barriers hinder implementation?"
   - Responses: "Stereotypes", "Lack of funding", "Low staff competence".
   - Categories: Cultural (30%), Resource (40%), Human resources (20%).

Table for Open-Ended Responses (Example):

Barrier Category	Number of Mentions	% of Total	Include in Round 2?
Cultural / Value-based	30	30	Yes
Resource (Financial)	40	40	Yes
Human Resources (Training)	20	20	Yes
Technical (IT access)	10	10	No (< 20%)

3. Interpretation of Results
- If the majority of components/interventions meet the consensus threshold (IQR ≤ 2, Me ≥ 7), they are included in the final model.
- If consensus is not achieved, the item is returned to **Round 3** for re-evaluation (with feedback on the previous round's Me and IQR).
- Open-ended responses serve as the basis for refining formulations in subsequent rounds.

Student Questionnaire Matrix
Topic: Reproductive Competence and Digital Well-Being of Female Students

Student Questionnaire Matrix

Components	Indicators	Item Numbers	Suggested Validation Sources
Cognitive	Knowledge of fertility, contraception, risks of delayed motherhood	7–10	Starrs et al., 2018 (Lancet); Ren et al., 2023 (Reprod Health); Chawłowska et al., 2020 (Front Public Health)
Bodily	Self-monitoring, use of cycle trackers, healthy habits, attention to bodily signals	11–14	Mogilevkina et al., 2016 (Eur J Contracept Reprod Health Care); Liu et al., 2025 (Sci Rep); Kozub et al., 2025 (Reprod Health of Woman)
Emotional	Self-regulation techniques, stress, exhaustion, coping resources	15–18	Cohen et al., 1983 (Perceived Stress Scale, adapted versions); Lushchak et al., 2024 (Lancet Reg Health – Eur); Alemu et al., 2017 (Biomed Res Int)
Social	Access to services, help-seeking, support, overcoming stigma	19–22	Davidson et al., 2022 (BMC Public Health); Syusyuka et al., 2025 (Reprod Health of Woman); Zenebe & Haukanes, 2019 (Int J Equity Health)

REPRODUCTIVE HEALTH OF WOMAN
РЕПРОДУКТИВНЕ ЗДОРОВ'Я ЖІНКИ
№8 (87)/2025
ISSN 2708-8723 (print)
ISSN 2708-8731 (online)

Components	Indicators	Item Numbers	Suggested Validation Sources
Digital	Digital hygiene, critical use of online resources, social media influence, balance	23–26	Nalwanga et al., 2021 (Reprod Health); Bucher et al., 2025 (BMC Women's Health); Zettergren et al., 2024 (BMC Health Serv Res)
Behavioral outcomes	Actual gynecological visits, contraceptive use, knowledge of access to support	27–29	Bearak et al., 2020 (Lancet Glob Health); Akoku et al., 2022 (PLoS One); Zhylka et al., 2021 (Reproductive Endocrinology)
General perception	Personal understanding of "reproductive health care"	30	Yari et al., 2015 (Glob J Health Sci); Qiao et al., 2024 (BMC Public Health)

Appendix B

Student Questionnaire

Topic: Reproductive competence and digital well-being among female students.
The objective: To assess knowledge, attitudes, behaviors, and psycho-emotional factors influencing reproductive competence.
Note: The survey is anonymous; results are used for scientific purposes only. Participants may skip any question.
Completion time: 8–10 minutes.

Section 1. Socio-demographic data

1. Age: ___
2. Year of study: 1/2/3/4/5/6
3. Field of study: Humanities/Technical/Medical/Other
4. Place of residence: Campus / Rented housing / With family / Other
5. Are you an internally displaced person? Yes/No
6. Experience of studying/living abroad: Yes/No

Section 2. Cognitive competence (knowledge)

Scale: 1 = strongly disagree; 5 = strongly agree

7. I understand how age affects female fertility.
8. I know about modern contraceptive methods and their effectiveness.
9. Postponing motherhood under stress may pose health risks.
10. I lack knowledge about reproductive health. *(reverse item)*

Section 3. Bodily competence (awareness and practice)

11. I monitor my menstrual cycle (app, calendar, other).
12. I know the signs that indicate reproductive health problems.
13. I do not pay attention to the signals of my own body *(reverse item)*
14. I maintain healthy habits (nutrition, sleep, physical activity) that support reproductive health.

Section 4. Emotional competence (stress and self-regulation)

15. I use techniques to reduce anxiety (breathing, relaxation).
16. I find it difficult to cope with stress during exams. *(reverse item)*
17. I often feel exhausted, which affects my health. *(reverse item)*
18. I feel inner resources to overcome crisis situations. *(Adapted from the Perceived Stress Scale – short version, 4 items).*

Section 5. Social competence (support and access)

19. I can seek help from university services (psychologist, medical office, mentor).
20. I know where to obtain anonymous counseling on contraception or STIs (Sexually Transmitted Infections).
21. I avoid discussing reproductive health even with close people. *(reverse item)*
22. I feel supported in making reproductive decisions.

Section 6. Digital competence (digital hygiene)

23. I can distinguish a reliable medical source from blogs or advertising.
24. I use mobile applications/telemedicine services to monitor my health.
25. Prolonged use of social media worsens my psycho-emotional state. *(reverse item)*
26. I consciously limit gadget use to maintain balance. *(Adapted from the Digital Well-being Index).*

Section 7. Behavioral outcomes

27. When was your last gynecological examination?
    – < 6 months / 6–12 months / 1–2 years / Never
28. Which contraceptive methods have you used in the past 12 months?
    – Hormonal pills / IUD (Intrauterine Device) / Condoms / Other / None
29. In case of an unintended pregnancy, I know where to seek help.
    – Yes / No / Not sure

Section 8. Open-ended question

30. What does "reproductive health care" personally mean to you? *(open response)*

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Стаття надійшла до редакції 19.09.2025. – Дата першого рішення 24.09.2025. – Стаття подана до друку 30.10.2025