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Sexual education and adolescents: a systematic review and meta-analysis

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ABSTRACT

Objective. Sexuality plays a significant role in human mental and physical health, well-being, and overall life satisfaction. Unfortunately, misinformation and lack of awareness remain barriers to access essential healthcare for adolescents. As a result of numerous scientific studies, many experts have reached the consensus that maintaining adolescents' sexual health requires comprehensive and scientifically accurate education and healthcare services. Therefore, the purpose of this systematic review and meta-analysis was to evaluate the impact of sexual education on the sexual health of adolescents.

Materials and Methods. The search was conducted in electronic databases including PubMed, Scopus, the Cochrane Library, Google Scholar, and ClinicalTrials.gov. 9 research articles, resulting in a total of 17,667 patients, that evaluated the impact of sexual education on the sexual knowledge of adolescent girls and boys, sexual initiation, unwanted pregnancy, abortions, and sexually transmitted diseases were included in this systematic review.

Results. The analysis of included studies presented that sexual education improves knowledge of contraception methods among adolescents ($p < 0.00001$) and the rate of unwanted pregnancies ($p = 0.02$), but no significant difference was obtained assessing the level of contraception use ($p = 0.39$) and the sexual experience ($p = 0.11$).

Conclusions. According to the results of our systematic review and meta-analysis, we emphasize the importance of sexual education and healthy lifestyle promotion in families and schools in early adolescence to improve adolescents' knowledge of contraceptive methods and reduce the incidence of unwanted pregnancies. However, further research is needed to gain a deeper understanding of the topic.

INTRODUCTION

Sexuality is an essential aspect of our lives, playing a significant role in human health and well-being. Modern scientific data proves that the sexual sphere directly affects mental and physical health and therefore overall life satisfaction. It was presented that sexual dysfunction is associated with several

general health comorbidities, which makes it vital to maintain sexual health [1].

Unfortunately, lack of quality sexual education, created by social and cultural norms, stigmatizes this area of our lives and directly contributes to poor sexual health outcomes. Social pressure, which leads to stigma, has been shown to increase emotional stress, resulting in a negative impact on mental condition and overall quality of life [2].

Adolescence is an important life stage that is characterized by significant physical growth and mental and social development. This period of development has a direct impact on the formation of an individual's personality in adulthood and lays the foundation for their reproductive and overall health [3]. Additionally, it is important to acknowledge that during this phase, a teenager may begin participating in sexual activities and experimentation. Early sexual initiation (ESI), typically defined as the first sexual experience occurring at or before the age of 15, is currently a common occurrence [4]. Scientific data from Canada provides that 30% of adolescents aged 15 to 17 years had intercourse at least once, whereas 10% of males and 8% of females report first genital intercourse occurring before age 15 years [5]. According to the US data, the early sexual debut was presented for 27.3% among boys and 20.7% among girls [6].

ESI is associated with risky behaviours such as unprotected intercourse or inconsistent contraceptive use, multiple sexual partners, and drug use [4]. These factors adversely affect adolescent sexual and reproductive health (SRH), increasing the risk of sexually transmitted diseases (STDs), unplanned pregnancies, abortions, and teen dating violence. SRH is an integral part of care for all adolescents, including those with special needs and chronic health conditions [5, 6].

Misinformation and lack of awareness remain barriers to access essential healthcare for adolescents. As a result of numerous scientific studies, many experts have reached the consensus that maintaining adolescents' sexual health requires comprehensive and scientifically accurate education and healthcare services [2, 3, 7].

Sexual education (SE) has a huge number of areas, aimed at addressing relevant issues in the field of adolescent sexual health. For example, the U.S. Centers for Disease Control and Prevention (CDC's) framework for SRH has been adapted to 7 topics: Partners, Practices, Protection from sexually transmitted infections (STIs), Past history of STIs, Prevention of pregnancy, Permission (consent), and Personal (gender) identity [5].

First, it is important to deal with the spread of sexually transmitted infections (STIs) among adolescents. Complications of untreated STIs should not be ignored; they include pelvic inflammatory diseases, chronic pelvic pain, infertility, and foetus or neonate pathologies. Complicated outcomes of untreated STIs, such as inflammatory conditions of the pelvis, chronic pelvic discomfort, infertility, and foetal or newborn pathologies, must not be disregarded. Currently, it has been demonstrated that the incidence of the human immunodeficiency virus (HIV) among young individuals is significantly influenced by the age of sexual debut. Adolescents who have experienced ESI are also at increased risk of human papillomavirus (HPV) infection due to the rapid physiologic changes and immature immune responses [4, 8]. This aspect requires special vigilance due to the social nature of this disease and the immediate threat of malignant neoplasms in infected individuals [9, 10]. Secondly, SE helps to address the issue of unwanted teenage pregnancies and abortions. Approximately 77% of adolescent pregnancies are unplanned, leading to abortions or abandonment of babies [7, 11, 12]. It has been noted that teenage mothers are at a higher risk of experiencing postpartum depression, dropping out of school, and living in poverty. This highlights the ongoing need for effective contraceptive education among adolescents [4, 13]. It is equally important to pay attention to the role of sexual education in ensuring reliable contraception for patients carrying BRCA1/2 genes, as there are a number of myths and misunderstandings that negatively affect the quality of life of such patients [14].

Despite the existing data, there is a lack of research that fully demonstrates the benefits of any particular type of sex education. A notable example is school-based health care (SBHC) programs, which provide accessible sexual, reproductive, and mental health services tailored to the needs of adolescents. The World Health Organization defines comprehensive sexuality education as providing accurate, age-appropriate information on sexuality and sexual and reproductive health [11, 15].

After carefully reviewing the available literature, we have selected this model of sexual education for evaluating in our systematic review and meta-analysis.

Despite the numerous aspects that comprise the topic of sex education, we have chosen to focus on

the effectiveness of school-based sexual education on the onset of sexual activity, sexual experience, the use of contraceptive methods, pregnancy rate, the prevention of unwanted pregnancies, abortions, and sexually transmitted diseases of adolescents.

METHODS

Study design and registration

The present systematic review included all published research articles that evaluated trials aimed at elucidating the impact of sexual education on sexual knowledge in adolescent girls and boys, sexual initiation, unwanted pregnancy, abortions, and sexually transmitted diseases. Our systematic review was conducted according to the PRISMA 2020 checklist [16].

Institutional Review Board (IRB) approval was not requested as this study is a review of published studies. The present systematic review has been registered in the PROSPERO international prospective register of systematic reviews by the National Institute for Health Research (NIHR). The registration number is PROSPERO 2022 CRD42022357877 [17].

Search strategy

The search was conducted independently by five investigators (J.A., E.K., Y.D., K.K., E.Z.) in PubMed, Scopus, the Cochrane Library, Google Scholar, and ClinicalTrials.gov from August 2023 to October 2023 to identify studies that reported the impact of sexual education on the sexual knowledge of adolescents, unwanted pregnancy, abortions, and sexually transmitted diseases, pregnancy rate, sexual initiation, incidence of STDs, contraceptive use, abortion rates, and knowledge of STDs, pregnancy, and contraceptive methods. The search consisted of controlled terms (*e.g.*, MESH) and text words for sex education, reproductive health, pregnancy, gynaecology, contraceptive methods, adolescents, contraception, girls, STDs, sexually transmitted diseases, and abortion. The retrieved records were imported in ZOTERO, and duplicate records were removed. Cited and citing references of the included studies were screened for additional relevant publications.

Inclusion criteria

We included randomized clinical trials (RCTs) and nonrandomized clinical trials (prospective controlled, prospective cohort, retrospective studies, and other types of studies) that included a minimum of 10 patients and were school-based. Intervention studies, animal studies, conference abstracts, and studies in languages other than English were excluded.

Study selection and data extraction

Five investigators (J.A., E.K., Y.D., K.K., E.Z.) independently read the full texts of the preselected articles to verify the eligibility of the articles based on their titles and abstracts with the use of COVIDENCE. After this step, studies were excluded if there were duplicate datasets. Any disagreements regarding the inclusion or exclusion of preselected studies and any other disagreements during the review process were resolved with the help of the sixth author (L.P.).

The included studies were independently collected by five authors (J.A., E.K., Y.D., K.K., E.Z.) using a standardized data extraction procedure (authors, publication year, study design, patient characteristics, intervention, and outcomes).

Quality assessment

Risk-of-bias assessment was conducted for each of the studies included using the Cochrane Handbook for Systematic Reviews of Interventions [18]. Five investigators (J.A., E.K., Y.D., K.K., E.Z.) independently assessed the quality of the selected studies. A fourth investigator (L.P.) was involved when disagreements occurred. Following the Cochrane Handbook for Systematic Reviews of Interventions, the RoB2 tool [19] was used to assess the risk of bias in randomized-controlled studies, and ROBINS-I [20] was used for non-randomized studies (prospective controlled, prospective cohort, retrospective studies, and other types of studies). These tools were also used to assess the risk of bias arising from reporting biases due to missing results in synthesis. The quality of evidence (QoE) was assessed according to the GRADE system [21].

Data synthesis

All statistical analyses were performed with Review Manager (RevMan 5.4) (recommended by the Cochrane Society).

RESULTS

Study selection

The whole search strategy with the results is presented in the PRISMA flow diagram (**Figure 1**).

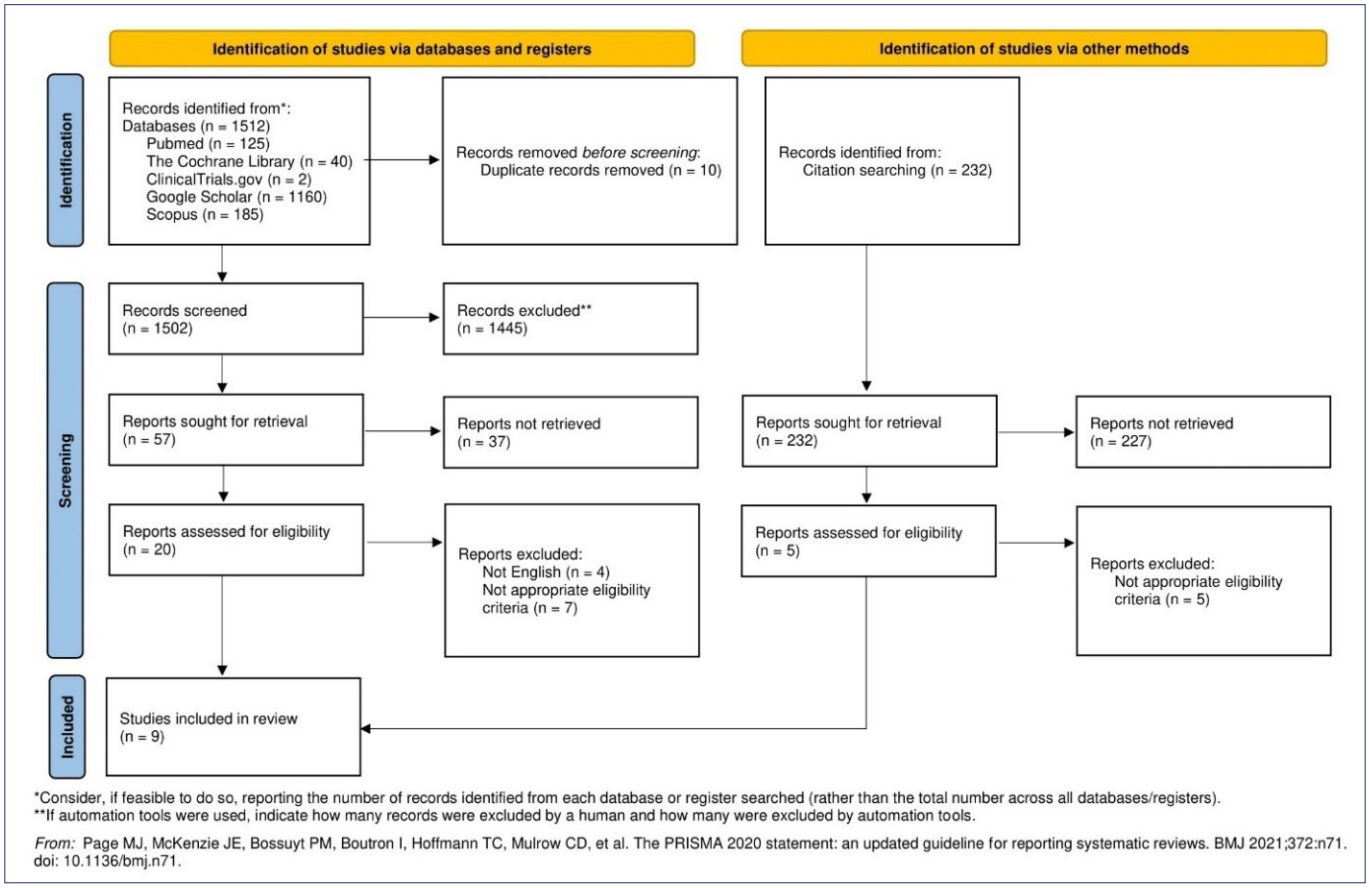

Figure 1. *Flow diagram of the literature search and study selection process according to the PRISMA guidelines.*

We used an electronic search of PubMed, Scopus, Google Scholar, Clinical Trials, and the Cochrane Library databases and received 1512 articles. After removing duplicates and searching for the title and abstract of the articles, 57 publications were selected. Of these, 37 articles were excluded after reading the full texts. Four studies were not in English [22-25]. Also, due to the absence of relevant inclusion criteria, 11 studies were excluded. 4 of them were not in English, and others were without appropriate inclusion criteria (**Table 1**).
Furthermore, we checked the references of the selected articles for acceptable studies (n = 232).

Table 1. *The list of excluded studies.*

n	Studies	Reasons for exclusion
1	Walker *et al.*, 2006 [25]	Absence of appropriate outcomes.
2	Kraft *et al.*, 2012 [41]	Absence of appropriate outcomes.
3	Constantine *et al.*, 2015 [42]	Absence of appropriate outcomes.
4	Li *et al.*, 2017 [39]	Absence of appropriate outcomes.
5	Netshikweta *et al.*, 2018 [43]	Absence of appropriate outcomes.
6	Dongarwar *et al.*, 2019 [44]	Absence of appropriate outcomes.
7	Marsiglio *et al.*, 1986 [45]	Absence of appropriate outcomes.

We selected 5 articles for full-text review, but all of them had inappropriate eligibility criteria.

Included studies

Therefore, a total of 9 studies were included in the qualitative synthesis of the systematic review [26-34], resulting in a total number of patients that is less in cohorts due to incomplete follow-up. Four studies were comparative [26, 28, 31, 34], three cluster randomized [30, 32, 33], one was an educational intervention [27] and one was prospective [29] (**Table 2**).

Type of intervention

The studies that investigated and compared the impact of sexual education on the sexual health of adolescents. The content of school-based sexual education programs of articles included in the systematic review is presented (**Table 3**).

Type of patients

A group of adolescents received school-based sexual education programs (n = 9,346) and a group of adolescents didn't receive school-based sexual education programs (n = 8,825) (17,667 patients totally).

Table 2. *Description of articles included in the systematic review.*

Study (first author)	Type of study	Participants/ population	Intervention(s), exposure(s)	Comparison(s)/ control	Outcome(s)
Knowledge of contraception methods					
G. Bogani 2017 [26]	Comparative Study	664 adolescents (median age 14 years)	First group: School-based sexual education programs (n = 559)	Second group: Without education (n = 105)	First group: 322 (58%) Second group: 42 (40%) (p<0.01)
A. M. Morenz 2019 [29]	Prospective study	520 female and male students (mean age 17.5)	Post-test (n = 503) After 2-h sexual education	Pre-test (n = 520) Before 2-h sexual education	Post-test n = 429 (85%) Pre-test n = 312 (60%) (p < 0.01)
S. R. Tortolero 2010 [30]	Cluster randomized study	907 adolescents (mean age 13.2 vs 13.0 years; data not shown)	First group: adolescents who received sex education (n = 349)	Second group: adolescents who didn't receive sex education (n = 558)	First group: 1.76±1.01 Second group: 1.64±1.03
Use of contraceptives					
G. Bogani 2017 [26]	Comparative Study	664 adolescents (median age 14 years)	First group: School-based sexual education programs (n = 559)	Second group: Without education (n = 105)	First group from 133: • Condom 73 (55%), • Hormonal contraception 20 (15%) Second group from 31: • Condom 17 (55%), • Hormonal contraception 5 (16%) (p = 1.00)
S. P. de Weiss 1991[32]	Cluster randomised trial	392 adolescents (12-19 years)	First group: sexual education (n = 211)	Second group: no education (n = 178)	First group: 31 (62%) from 50 Second group: 28 (62.3%) from 45
J. Stephenson 2008 [33]	Cluster randomised trial	Pupils (n = 8,766)	First group: usual teacher-led sex education (n = 4 250)	Second group: peer-led sex education (n = 4 516)	Girls: First group: 854 (86.35%) from 989 Second group: 631 (84.47%) from 747 Boys: First group: 650 (87.01%) from 747 Second group: 509 (87.76 %) from 580
M. Taylor 2014 [34]	Comparative Study	679 adolescent (15-19 years)	First group: adolescents who received sex education (n = 383)	Second group: adolescents who didn't receive sex education (n = 296)	First group: 39 (54.2%) from 72 Second group: 11 (36.7%) from 30 (p < 0.01)
B. Wang 2008 [31]	Comparative Study	2,227 participate (15-24 years)	First group: Post-test (n = 1,148) -boys- 678 -girls- 470	Second group: Pre-test (n = 1,148) -boys- 678 -girls- 470	Boys Pre-test: 3,5 from 12 Post-test: 8,4 from 12 Girls Pre-test: 2,6 from 12 Post-test: 8,2 from 12 (p < 0.001)
Unwanted pregnancy rate					
P. K. Kohler 2007 [27]	Comparative Study	1,719 adolescents (15-19 years): - girls 47.4% - boys 52.6%	First group: adolescents who received comprehensive sex education (n = 1,161) Third group: adolescents who received abstinence-only education (n = 390	Second group: adolescents who didn't receive sex education (n = 168)	Pregnancy rate (Weighted% (95%CI)) First group: 53.5 (42.3–64.5) Second group: 19.4 (13.2–27.4) Third group: 27.1 (17.7–39.1)
D. Malovizky 1997 [28]	Educational intervention study	1,793 women (close to the age of 18 years)	First group: adolescents who received comprehensive sex education (n = 968)	Second group: adolescents who didn't receive sex education (n = 825)	First group: 25 (2.6%) Second group: 33 (4%)
J. Stephenson 2008 [33]	Cluster randomised trial	Pupils (n = 8,766)	First group: usual teacher-led sex education (n = 4,250)	Second group: peer-led sex education (n = 4,516)	First group: 103 (7.65%) from 1,346 Second group: 93 (9.96%) from 934

Study (first author)	Type of study	Participants/ population	Intervention(s), exposure(s)	Comparison(s)/ control	Outcome(s)
M. Taylor 2014 [34]	Comparative Study	679 adolescent (15-19 years)	First group: adolescents who received sex education (n = 383)	Second group: adolescents who didn't receive sex education (n = 296)	First group: 5 (6.3%) from 80 Second group: 2 (4.4%) from 46
Sexual experience					
P. K. Kohler 2007 [27]	Comparative Study	1,719 adolescents (15-19 years):	First group: adolescents who received comprehensive sex education (n = 1161) Third group: adolescents who received abstinence-only education (n = 390)	Second group: adolescents who didn't receive sex education (n = 168	Weighted % (95% CI)) First group: 66.0 (61.6–70.2) Second group: 11.5 (8.9-14.7) Third group: 22.6 (19.1- 26.5) (p = 0.06)
S. P. de Weiss 1991 [32]	Cluster randomised trial	392 adolescents (12-19 years)	First group: sexual education (n = 211)	Second group: no education (n = 178)	First group: 50 (23.69%) from 211 Second group: 45 (25.28%) from 178
M. Taylor 2014 [34]	Comparative Study	679 adolescent (15-19 years)	First group: adolescents who received sex education (n = 383)	Second group: adolescents who didn't receive sex education (n = 296)	First group: 82 (21.4%) Second group: 47 (15.9%)
S. R. Tortolero 2010 [30]	Cluster randomised trial	907 adolescents (mean age 13.2 vs 13.0 years; data not shown)	First group: adolescents who received sex education (n = 349)	Second group: adolescents who didn't receive sex education (n = 558)	First group: 37 (10,6%) Second group: 46(8,3%)
Knowledge of HIV/STD transmission					
G. Bogani 2017 [26]	Comparative Study	664 adolescents (median age 14 years)	First group: School-based sexual education programs (n = 559)	Second group: Without education (n = 105)	First group: 458 (82%) Second group: 75 (71%) (p = 0.01)
S. R. Tortolero 2010 [30]	Cluster randomised trial	907 adolescents (mean age 13.2 vs 13.0 years; data not shown)	First group: adolescents who received sex education (n = 349)	Second group: adolescents who didn't receive sex education (n = 558)	First group: 0.57±0.31 Second group: 0.55±0.29
B. Wang 2008 [31]	Comparative Study	2,227 participate (15-24 years)	First group: Post-test (n = 1,148) -boys- 678 -girls- 470	Second group: Pre-test (n = 1148) -boys- 678 -girls- 470	Boys Pre-test: 5,7 from 12 Post-test: 8,1 from 12 Girls Pre-test: 5.1 from 12 Post-test: 8,1 from 12 (p < 0.001)
STD diagnosis					
P. K. Kohler 2007 [27]	Comparative Study	1,719 adolescents (15-19 years): - girls 47.4% - boys 52.6%	First group: adolescents who received comprehensive sex education (n = 1,161) Third group: adolescents who received abstinence-only education (n = 390	Second group: adolescents who didn't receive sex education (n = 168)	(Weighted % (95% CI)) First group: 73.4 (59.5–83.8) Second group: 6.9 (3.0–15.4) Third group: 19.7 (11.1–32.6) (p = 0.55)
Knowledge of pregnancy					
A. M. Morenz 2019 [29]	Prospective study	520 female and male students (mean age 17.5)	Post-test (n = 503) After 2-h sexual education	Pre-test (n = 520) Before 2-h sexual education	Post-test: n = 461 (92%) Pre-test: n = 187 (36%)
Abortion rate					
J. Stephenson 2008 [33]	Cluster randomised trial	Pupils (n = 8,766)	First group: usual teacher-led sex education (n = 4 250)	Second group: peer-led sex education (n = 4,516	Abortion rate First group: 53 (3.91%) from 1,356 Second group: 48 (5.11%) from 939

Risk of bias assessment

According to the Cochrane Handbook for Systematic Reviews of Interventions, the risk of bias of included studies was assessed independently by five reviewers (J.A., E.K., Y.D., K.K., E.Z.), using ROBINS-I [20] for non-randomized studies and RoB 2 [19] for randomized control trials. Any disagreements were resolved by discussion with the sixth author (L.P.). The ROBINS-I tool included bias due to confounding, bias in the selection of study participants, bias in the classification of interventions, deviations from intended interventions, bias due to missing data, bias in the measurement of outcomes, and bias in the selection of the reported results. Each of the items was classified as critical, serious, low risk of bias, or no information. The Rob 2 tool included bias arising from the randomization process due to deviations from intended interventions, missing outcome data, bias in the measurement of the outcome, and bias in the selection of the reported result. Each of the items was classified as high, of some concern, or indicating low risk of bias. Visualization tools were created by the ROBVIS app. This app created "traffic light" plots of the domain-level judgements for each result and weighted bar plots of the distribution of risk-of-bias judgments within each bias domain. The overall risk of bias for non-randomized trials was serious in 33% and moderate in 67%, according to the ROBINS-I tool, and based on the RoB 2 tool (**Figure 2**), randomized trials had 100% some concerns regarding the overall risk of bias.

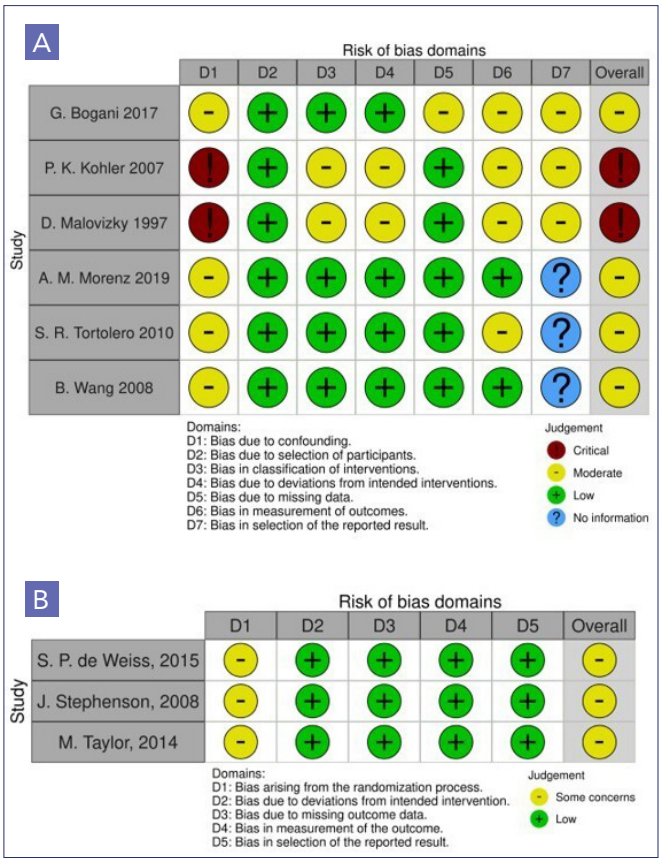

Figure 2. *(**A**) ROBINS-I tool for non- randomized trials; (**B**) RoB 2 tool for randomized trials.*

Effects of intervention

The primary outcome was the impact of sexual education on the knowledge of contraceptive methods. The secondary outcome was the impact

Table 3. *Content of school-based sexual education programs of articles included in the systematic review..*

Study (first author)	Content of school-based sexual education programs
G. Bogani 2017 [26]	Anatomy, reproduction, health, responsibilities, STDs, birth control, abstinence.
P. K. Kohler 2007 [27]	Formal sex education (abstinence-only) OR comprehensive sex education (both "saying no to sex" and birth control)
D. Malovizky 1997 [28]	Sexuality, anatomy and physiology of the reproductive system, contraceptive methods, pregnancy and childbirth, decision-making processes, interpersonal relationships, pregnancy prevention, STDs, personal hygiene
A. M. Morenz 2019 [29]	Adolescent sexuality, demographic information regarding adolescent pregnancy, complications during pregnancy, methods of birth control and protection from STD
S. R. Tortolero 2010 [30]	A life skills decision-making paradigm (Select, Detect, Protect), setting personal limits and practicing refusal skills related to sexual behavior, characteristics of healthy dating relationships; reproduction and STDs, importance of HIV, STI, and pregnancy testing if person is sexually active; skills training condom and contraceptive use; parent–child homework activities to facilitate dialogue on such topics as friendship qualities, dating, and sexual behavior
B. Wang 2008 [31]	Abstinence, sexuality, contraception, HIV/AIDS prevention, healthy sexual behaviors
S. P. de Weiss 1991 [32]	How to prevent pregnancy, where to obtain contraceptives, relationship with sex partner, sexuality
J. Stephenson 2008 [33]	Skills in sexual communication and condom use, pregnancy, STDs, contraception, local sexual health services
M. Taylor 2014 [34]	Modules: «Knowing Yourself», «The Choice is Yours», «Relationships», «Making Choices», «Body Development», «Contraception», «Peer Pressure», «Culture», «Parenthood», «Responsibility», «Human Rights», «Gender».

of sexual education on the use of contraceptives. The tertiary outcome was the impact of sexual education on unwanted pregnancies. The quaternary outcome was the impact of sexual education on the sexual experience of adolescents.

Sensitivity analysis

According to the Cochrane Handbook for Systematic Reviews of Interventions, an I^2 value of 0 indicates no observed heterogeneity, whereas I^2 values from 30% to 60% may represent moderate heterogeneity, I^2 values from 50% to 90% may represent substantial heterogeneity, and I^2 values from 75% to 100% represent considerable heterogeneity.

Knowledge of contraception methods

The level of knowledge about contraception among adolescents was assessed by three studies. Bogani *et al*.'s study [26] presented that students who received school-based sexual education have significantly better knowledge about methods of contraception than students' groups without education (58% *vs* 40% ($p < 0.01$)). The same results were demonstrated by Morenz *et al*. [29] (85% *vs* 60% ($p < 0.01$)) and Tortolero *et al*.'s [30] studies.

Also, we have done the primary analysis as a meta-analysis of two studies by Bogani *et al*. [26] and Morenz *et al*. [29] with a total of 1,184 adolescents: RR = 1.42, 95%CI 1.32 to 1.54, $p < 0.00001$. The heterogeneity for this comparison was 0%. Consequently, sex education shows better knowledge of contraception methods among adolescents who received sex education compared to adolescents who did not (**Figure 3**).

Use of contraceptives

Such an important parameter as use of contraceptives by adolescents was investigated by five studies. A study by Bogani *et al*. [26] showed that the use of condoms was the same in groups of students who received or didn't receive school-based sexual education, and the use of hormonal contraception was higher in the group without sexual education, but the difference wasn't significant. de Weiss *et al*.'s study [32] presented similar results, showing that the group without sexual education had a higher percentage of contraception using, but the difference was also insignificant. Although Taylor *et al*.'s study [34] demonstrated that the presence of sexual education had a positive effect on the test results of students (54.2% *vs* 36.7% ($p < 0.01$)). Also, the authors proved that the results of students after completing the course of sexual education were significantly better than before it (8.4 *vs* 3.5 among boys and 8.2 *vs* 2.6 among girls ($p < 0.001$)). Stephenson *et al*.'s study [33] compared use of contraceptives between students who received teacher-led education, with students who received peer-led sexual education and demonstrated that the results of the second group were better among boys, whereas among girls, the teacher-led education group showed better results.

The secondary analysis was conducted to compare the use of contraceptives. Four studies [26, 32-34] were included in the meta-analysis: RR = 1.01, 95%CI 0.98 to 1.04, $p = 0.39$. The heterogeneity for this comparison was 0%. Based on our analysis, it can be concluded that there is no significant difference in the level of contraception use by adolescents who received sex education compared to adolescents who did not (**Figure 2**).

Unwanted pregnancy rate

The percentage of unwanted pregnancies among adolescents was assessed by four studies. In Kohler *et al*.'s study [27] the group that received comprehensive sex education demonstrated the highest pregnancy rate, whereas the group that received abstinence-only sex education demonstrated a higher pregnancy rate than students without sex education. Taylor *et al*.'s study [34] showed similar results: the group that received sex education demonstrated higher pregnancy rate than students who didn't. However, in Malovizky *et al*.'s study [28], pregnancy rate of adolescents received comprehensive sex education was lower than among adolescents, didn't receive sex education. Interestingly, Stephenson *et al*.'s study [33] presented that a teacher-led sex education group of adolescents demonstrated a higher pregnancy rate than students who passed peer-led sex education.

In the third analysis, we compared the rates of unwanted pregnancy. Three studies were included in the meta-analysis [28, 33, 34]: RR = 0.75, 95%CI 0.59 to 0.95, $p = 0,02$. The heterogeneity for this comparison was 0%. Based on the data obtained, the rate of unwanted pregnancies is significantly lower in adolescents who received sexual education (**Figure 2**).

Sexual experience

The sexual experience among adolescents was also investigated. In Kohler *et al*. study [34] comprehensive sex education group demonstrated the most

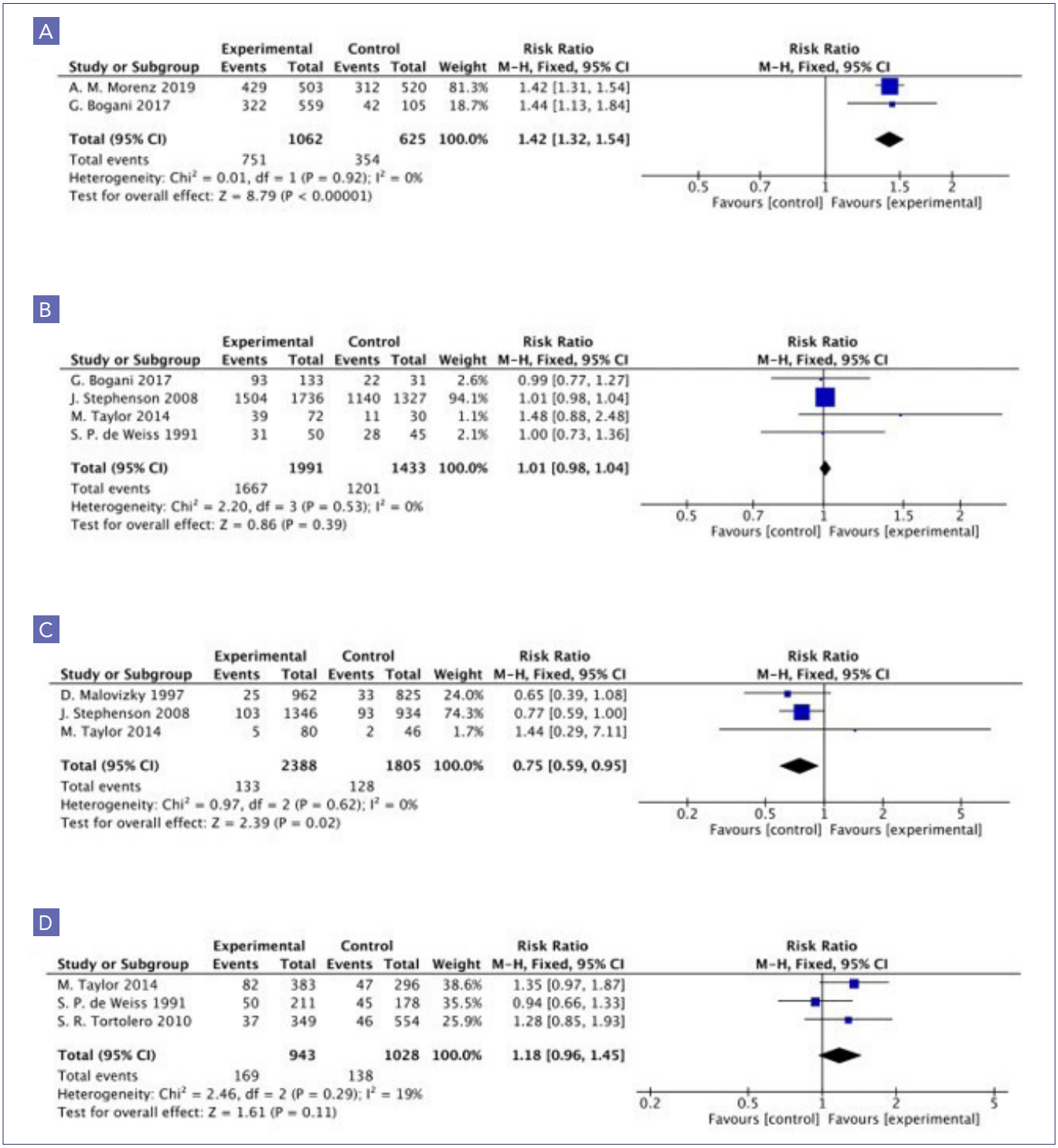

Figure 3. *Meta-analysis: (**A**) of knowledge of contraceptive methods; (**B**) of the use of contraceptives before/after sexual education programs; (**C**) of the incidence of unwanted pregnancy; (**D**) of sexual experience in two groups.*

sexual experience (66.0 (61.6-70.2)), whereas a no-education group had the least (11.5 (8.9-14.7)), and an abstinence-only sex education group's results were in the middle (22.6 (19.1-26.5) ($p < 0.06$)). In de Weiss *et al*.'s study [32] adolescents without sex education had bigger sexual experience; however in Taylor *et al*.'s and Tortolero *et al*.'s studies [30, 34], conversely, sex education group demonstrated a bigger sexual experience than adolescents who didn't receive sex education.

The fourth analysis was done also as a meta-analysis of three studies [30, 32, 34]: RR = 1.18, 95%CI 0.96 to 1.45, p = 0,11. The heterogeneity for this comparison was 19%. Our analysis showed that there is

no significant difference in the sexual experience between adolescents who received sex education compared to those who did not receive it (**Figure 2**).

Knowledge of HIV/STD transmission

In Bogani *et al*.'s study [26] knowledge about the transmission of HIV and STDs among adolescents was assessed, and the results showed that students who received sexual education courses had better knowledge than those who didn't (82% *vs* 71% (p = 0.01)). The same data was demonstrated by the Tortolero *et al*. study [30]. Also, in Tortolero *et al*.'s study 26 post-educational results of adolescents were much better than before sex education among both boys and girls ($p < 0.001$).

STD diagnosis

In Kohler *et al*.'s study [27] group of adolescents who received comprehensive sex education demonstrated the highest rate of STD (73.4 (59.5-83.8)). In the second place was the group that received abstinence-only sex education (19.7 (11.1-32.6)), and no education group was in last place (6.9 (3.0-15.4) (p = 0.55)).

Knowledge of pregnancy

A study by Morenz *et al*.'s [29] demonstrated that the sex education lesson had significantly increased the level of knowledge about pregnancy (36% for the pre-test *vs* 92% for the post-test group).

Abortion rate

Stephenson *et al*.'s study [33] assessed abortion rates among adolescents, demonstrating that it was higher in the group that attended teacher-led sex education compared with the group that attended peer-led sex education, including adolescents (5.11% *vs* 3.91%).

DISCUSSION

Sexual education plays a vital role in shaping the sexual health outcomes of adolescents worldwide. At the same time, it has always been a sensitive topic and causes a lot of controversy.

This study aimed to evaluate the impact of sexual education on the sexual knowledge of adolescents, unwanted pregnancy, abortions, and sexually transmitted diseases, pregnancy rate, sexual initiation, incidence of STDs, contraceptive use, abortion rates, and knowledge of STDs, pregnancy, and contraceptive methods. The findings of our systematic review and meta-analysis highlight the statistically significant importance of implementing sex education regarding the following topics: knowledge about contraception methods (RR = 1.42, 95%CI 1.32 to 1.54, $p < 0.00001$) and rate of unwanted pregnancies (RR = 0.75, 95%CI 0.59 to 0.95, p = 0.02). However, the data obtained on the impact of sexual education on the level of contraceptive use (RR = 1.01, 95%CI 0.98 to 1.04, p = 0.39) and sexual experience of adolescents (RR = 1.18, 95%CI 0.96 to 1.45, p = 0.11) were not reliable and need further investigation. Particular attention should be paid to the study of the impact of sex education on the use of contraceptives by adolescents, which directly affects the rate of unplanned pregnancies and unsafe abortions, which in turn causes significant harm to the health of adolescents and entails economic and social difficulties [35].

Results of our work correlate with the results of the following systematic review by Gamelia *et al*. [36] in terms of potentially significant decreasing of teenage pregnancy, STDs, and risky sexual behaviour. Furthermore, scientific evidence collected by the World Health Organization together with UNESCO and several other international organizations proves that introducing sexuality education in schools would be beneficial to society [37].

Sex education promotes good attitudes regarding sexual and reproductive health – and thus reduces the risks of contracting HIV and sexually transmitted infections. For example, in countries where sex education is organized at a systemic level – such as the Netherlands, Finland, and Sweden - the incidence rates of HIV/STIs and early pregnancy and, as a result, abortions are much lower [37, 38].

Every year, an estimated 21 million girls aged 15-19 years in developing regions become pregnant, and approximately 12 million of them give birth [38]. Sex education classes should reduce the number of abortions among teenagers. In many countries, adolescents are unable to avoid unwanted pregnancy due to circumstances that prevent them from obtaining and using contraceptives [37].

Our systematic review and meta-analysis includes 9 studies out of 1,512 publications, and this is the first study that assessed the effectiveness of adolescent sex education in terms of pregnancy rate, sexual initiation, incidence of STDs, contraceptive use, abortion rates, and knowledge of STDs, pregnancy, and contraceptive methods.

Moreover, during the research we have found a great number of studies that demonstrated the po-

sitive impact of sexual education in adolescents on various aspects that we did not analyse, such as knowledge about sexual health and sexual health services, attitudes about sexual relationship rights, communication about sex and relationships with parents, and self-efficacy to manage risky situations at immediate post-test [39].

Thus, sexual education is a complex subject; it covers a wide range of topics, for instance, bullying, depression, anxiety, low self-esteem, substance abuse, suicide attempts, and unstable housing, which are being discussed in several studies [40]. These questions were not the focus of our study but needed to be reviewed in the future.

Limitations of our systematic review and meta-analysis were the small number of included studies and participants that made it difficult to generalize the results. In addition, some of the studies included in this article were of low quality and presented moderate and critical risk of bias, which also negatively affected the results of data analysis. We need more high-quality clinical trials and low risks of bias to discuss this problem more evidence-based. Some studies included not only female patients but also male patients. Another limitation of the studies is relatively short follow-up and subsequent inability to assess the long-term prospects for unwanted pregnancies. One more limitation of our study is the high heterogeneity of the included groups of participants, which was influenced by various school sexual education programs, as well as cultural distortions, which did not allow for a qualitative analysis of the data and negatively affected the results.

Concerning implications for future research, they may include well-performed study design and long-term follow-up to assess the impact of sexual education on adolescents. Also, more studies and meta-analysis evaluating the impact of sex education on abortion rates in adolescence are needed. It is also necessary to divide studies on the impact of sex education by gender. And decide at what age sex education lessons are most effective.

Overall, this systematic review and meta-analysis highlights the positive impact of comprehensive sex education on the sexual health outcomes of adolescents and underscores the importance of continued research in this area. By prioritizing evidence-based approaches and promoting a holistic understanding of sexuality, we can empower young people to make informed choices and lead healthy, fulfilling lives.

CONCLUSIONS

The present systematic review and meta-analysis suggested that school-based sexual education programs improve, in a statistically significant way, sexual knowledge among adolescents regarding the following topics: knowledge about contraception methods and rate of unwanted pregnancies, but the difference in the level of contraceptive use and sexual experience of adolescents was not statistically significant. Adults have to overcome taboo and reluctance to confront sexual issues with adolescents. Comprehensive sexual and reproductive health education and counselling could potentially avert a significant number of teenage pregnancies in these settings. Further research is needed in order to form a more complete understanding of the role of sexual education in the sexual health of adolescents.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' contribution

L.P., J.A.: Conceptualization, methodology, project administration, supervision, formal analysis. E.K., Y.D.: Writing – review & editing, validation, visualization. K.K., E.Z.: Investigation, writing – original draft.

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Study registration

PROSPERO international prospective register of systematic reviews by the National Institute for Health Research (NIHR). The registration number is PROSPERO 2022 CRD42022357877.

Disclosure of interests

The authors declare that they have no conflict of interests.

Ethical approval

N/A.

Informed consent

N/A.

Data sharing

Data are available along with the review.

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