SYSTEMATIC REVIEW

Preconception health interventions delivered in public health and community settings: A systematic review

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ABSTRACT

OBJECTIVES: The objective of this systematic review was to assess the effects of preconception health interventions, delivered to individuals of reproductive age in public health and community settings, on reproductive, maternal, and child health outcomes.

METHODS: A search of Ovid MEDLINE, CINAHL, EMBASE, PsychINFO, Scopus, Gender Studies Database, and SocINDEX from July 1999 through July 2016 was performed. We included studies that reported original data, used an interventional study design, included reproductive-aged women or men, were written in English, and were published in peer-reviewed journals. Two reviewers independently used standardized instruments for data extraction and quality assessment. A narrative synthesis was performed.

SYNTHESIS: Twelve studies met the inclusion criteria. These studies included randomized controlled trials and quasi-experimental, pre–post, and time-series designs. Most studies were conducted in the United States; all but one study included only women. Interventions were mainly educational initiatives focused on nutrition, immunization, and lifestyle behaviours and were delivered in a single contact. The studies reported positive effects on health knowledge (n = 9), behaviour change (n = 4), and health outcomes (n = 1). Study quality was weak (n = 11) or moderate (n = 1), with limitations related to selection bias, blinding, data collection methods, and participant attrition.

CONCLUSION: To develop a comprehensive, standardized approach to preconception health promotion and care in Canada, there is a clear need for high-quality research evaluating the effectiveness of preconception health interventions. Studies should use a health equity lens that includes all individuals of reproductive age and addresses the broad determinants of preconception health.

KEY WORDS: Health promotion; preconception care; public health

La traduction du résumé se trouve à la fin de l'article.

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Despite advances in medicine and universal access to prenatal care, poor perinatal outcomes persist in Canada. Many individuals are not in good health at conception,[1] and ever-growing research suggests that preconception health affects reproductive, maternal, and neonatal health outcomes.[1,2] Preconception health describes the health of all individuals during their reproductive years with a particular focus on reducing risk factors, promoting healthy lifestyle behaviours, and increasing readiness for pregnancy, regardless of sex, sexual orientation, or whether or not individuals plan to have children.[3] There is mounting consensus that interventions before conception are necessary to improve perinatal outcomes.[4] Many risk factors for poor birth outcomes, such as lifestyle behaviours, are modifiable in the preconception period with appropriate individual intervention and public policy initiatives.[5–7] Improved preconception health promotes fertility, prevents congenital anomalies, decreases the rate of preterm birth, improves birth weight, and reduces infant and maternal mortality.[1,8–12] However, approximately 50% of pregnancies are unplanned.[13] Every contact between individuals of reproductive age and health care providers in clinical, public health, and community settings is an opportunity to discuss preconception health issues such as chronic medical conditions, mental health, sexual health, environmental exposures, nutrition, immunization, physical activity, lifestyle behaviours, and reproductive life planning.[14–16] The first prenatal appointment, when many of these topics are often addressed, is too late.[17]

A recent position paper by the Ontario Public Health Association identified barriers to optimal preconception health in Canada.[18] Although Canada has achieved some progress in this field in recent

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years, a comprehensive, standardized approach to preconception health promotion and care with specific guidelines is absent both provincially and federally.[18] In Ontario, for example, where preconception health promotion is mandated under the Ontario Public Health Standards,[19] public health units have no uniform program to follow and are left to prioritize resources and develop and implement programming according to local need.[18] One of the major barriers to preconception health in Canada is the lack of data on interventions and their effectiveness. There is growing evidence to suggest that interventions promoting preconception health delivered in primary care settings may improve knowledge, self-efficacy, and health locus of control, and reduce poor lifestyle behaviours.[20] These interventions tend to address risk factors in high-risk populations (e.g., women with chronic medical conditions).[18] However, given the wide scope of preconception health and the high rate of unplanned pregnancies, it is important that preconception health promotion and care also be delivered to individuals in public health and community settings, in addition to primary care, to maximize population impact. There is a need to identify and assess preconception health interventions that adopt a broader health promotion and prevention approach and that are suitable for delivery in public health and community settings (e.g., education programs, public awareness campaigns, peer support, interactive electronic risk assessments, healthy public policy, and supportive environments).

The objective of this systematic review was to assess the effects of preconception health interventions, delivered to individuals of reproductive age in public health and community settings, on reproductive, maternal, and child health outcomes.

METHODS

Search strategy

We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.[21] An expert librarian searched seven databases in July 2016. These databases were Ovid MEDLINE, CINAHL, EMBASE, PsychINFO, Scopus, Gender Studies Database, and SocINDEX. Searches were conducted of article titles, abstracts, and keywords or descriptors employing combinations of the following search terms: "preconception care" or "preconception assessment" or "preconception health" or "pre-pregnancy care" or "pre-pregnancy assessment" or "periconception care" or "periconception assessment" or "periconception health" AND "public health" or "health promotion" or "health prevention" or "preventative health" or "community health service" or "community health care" or "community clinic" or "family planning service" or "ambulatory care" or "urgent care clinic" or "primary health care" or "family doctor" or "family practice" or "general practice." Where possible, all terms were included as full text, truncation being used to capture variation in terminology. The database search was limited to the period July 1999 to July 2016; the start date was selected following the end of a search of an earlier review by Korenbrot et al.[22] Hand searches of the reference lists of included articles were also performed.

Selection criteria

For inclusion in the review, studies were required to fulfill the following criteria: a) reported original data on the effectiveness of preconception health interventions aimed at improving reproductive, maternal, or child health outcomes; b) used an interventional study design (e.g., randomized controlled trial, quasi-experimental, pre–post, or interrupted time series design); c) included women or men of reproductive age (15–45 years); d) were written in English; and e) were published in a peer-reviewed journal. We included both primary interventions (e.g., advice on environmental exposures, mental health, sexual health, nutrition, immunization, physical activity, lifestyle behaviours, or reproductive planning) and secondary prevention interventions (e.g., screening for genetic disorders or chronic medical conditions such as diabetes).

Studies were excluded if the article a) did not report original data (e.g., meta-analyses, review papers, commentaries); b) used a purely observational study design (e.g., cohort studies, case-control studies) or did not have a comparison group; or c) included women or men with specific medical needs (e.g., diabetes, human immunodeficiency virus) or women who were already pregnant. All titles and abstracts were reviewed independently by three reviewers (HKB, MM, and SAE) for relevance.

Data extraction and management

All selected abstracts were compared across the three reviewers (HKB, MM, and SAE) and, upon agreement, the full articles were retrieved. From the included studies, information on the date of publication, study design, location, setting of the study, study population, participation rate, duration of participation, type of intervention(s), type of outcome(s), analysis approach, and findings with their statistical significance were extracted using a standardized extraction form.

Quality assessment

Each study was critically appraised by two assessors (from among HKB, MM, and SAE); a third assessor was used to adjudicate disagreements ($n = 1$). We employed the Effective Public Health Practice Project Quality Assessment (EPHPP) tool.[23] Developed by Canadian public health professionals, the EPHPP has been validated and is widely used in public health research.[23] The tool rates articles as strong, moderate, or weak on the basis of the following domains: a) selection bias, b) study design, c) confounding, d) blinding, e) data collection methods, and f) withdrawals and dropouts.

Analysis approach

We planned to perform a quantitative synthesis of the data using either fixed effects meta-analysis (in the absence of heterogeneity) or random effects meta-analysis (in the presence of heterogeneity). However, given the substantial diversity of the study populations, interventions, and outcomes among the retrieved articles, it was not possible to complete a meta-analysis. Instead, we performed a narrative synthesis.

RESULTS

Characteristics of included studies

The literature search yielded 3045 records (Figure 1). Following removal of duplicates, 2100 records were retained. We excluded 2066 articles on the basis of title and abstract review. Through the

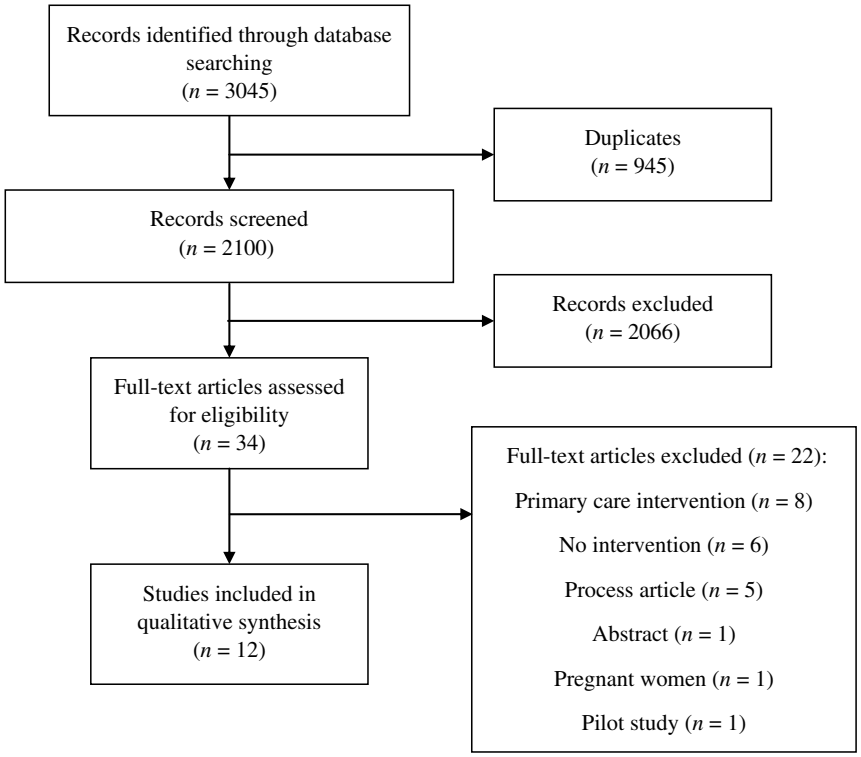

Figure 1. Summary of studies selected for inclusion.

search, a recent systematic review of preconception health interventions in primary care settings was identified.[20] As such, these studies of primary care interventions (n = 8) were excluded from the current review. Additionally, we excluded articles that had no intervention (i.e., purely observational or descriptive designs), included only pregnant women, described only the process or program with no outcome measurement, or were incomplete (e.g., abstracts only, pilot studies). In total, 12 studies met the inclusion criteria for our search.[24–35] (See the Supplementary file, in the ARTICLE TOOLS section on the journal site.) No additional studies were identified through hand searches of these studies.

The 12 studies identified represent study periods spanning 1994 through 2013 in three countries (Table 1). A majority of studies (n = 8, 67%) were conducted in the United States,[25,27–33] three in Australia,[26,34,35] and one in Italy.[24] Study designs included randomized controlled trials (n = 5, 42%),[25,28,31,32,34] quasi-experimental studies (n = 1, 8%),[30] pre–post studies (n = 5, 42%),[24,26,27,29,33] and interrupted time series (n = 1, 8%).[35] In total, four studies (33%) had sample sizes greater than 500 subjects.[28,30,34,35] Only four studies (33%) provided participation rates, which ranged from 32% to 77%.[24,25,27,32] Four studies (33%) recruited specific groups of individuals, including female college students[27,32,33] and African American women.[29] Only one study (8%) included men.[29] Participants were recruited using a variety of strategies: online,[24] E-mail,[32] and telephone invitations[26,35] and in-person approaches in a number of settings, such as colleges[33] and shopping malls.[30]

The interventions identified focused on a range of risk factors related to adverse perinatal outcomes, including chronic and genetic diseases,[24,33] stress,[28] sexually transmitted diseases,[24,27,28,33] nutrition and folic acid supplementation,[24–27,28,31–35] vaccinations,[24,33] physical activity,[24,27] tobacco exposure,[24,28,33] and alcohol use.[24,28,33] Delivery of information was varied and included tailored documents based on individual risk information,[24] simple print materials such as posters and brochures,[26,30,34] and web-based platforms such as Twitter[31] and E-mail.[32] In addition, two studies examined media campaigns delivered by radio and billboards.[29,35] Four studies (33%) used education sessions ranging from a single 15-minute computerized intervention[25] to instructor-led group sessions of 90–120 minutes.[27,28,33] Four studies (33%) had intensive interventions involving multiple contacts.[27,28,31,32] However, a majority (n = 8, 67%) had only a single contact. Half of the studies (n = 6) had no follow-up period (i.e., outcomes were assessed immediately after the intervention).[26,29,30,33–35] Among those with a follow-up period, two had a duration of less than 2 weeks,[28,31] two had a duration of between 4 and 6 weeks,[27,32] and two had a duration of 6 months.[24,25]

Study outcomes were grouped into three broad categories: knowledge increase, behaviour change, and health outcomes (Table 2). Most of the studies (n = 9, 75%) examined individuals' knowledge of preconception health.[24–27,29,30,33–35] These studies varied in the type of intervention as well as the topics selected to assess knowledge increase. Examples of knowledge tested include general preconception health, folic acid intake and its effects, types of foods enriched with folate, and risks of smoking and alcohol exposures. All studies measuring knowledge increase reported statistically significant increases in knowledge. Four studies examined self-reported change related to a specific health behaviour, such as using folic acid supplements,[24,25,28,32]

Description of included studies (n = 12)

	Design	Study period	Location	Population/no. participants	Intervention(s)	Follo
	Pre–post	September 2011–May 2013	Italy	**Criteria:** Italian-speaking women aged 18–45 years with plan of getting pregnant in following year **Recruitment:** Self-referred online **Sample size:** 282 **Participation rate:** 56.7%	**Approach:** Tailored, individual education document **Content:** Based on self-reported risk factors; recommendations based on ACOG guidelines; provided details on exposure, associated adverse events and strategies to change behaviours **Delivery:** Online; encouraged to take document to physician	**Duration:** 6 **Follow-up r**
rz	RCT	March 2005–2006	US	**Criteria:** English-speaking women aged 18–45 years **Recruitment:** Urgent care centre waiting rooms **Sample size:** 446 **Participation rate:** 42%	**Approach:** One 15-minute counselling session; women also received 200 folate tablets at the end of the counselling session **Content:** Periconceptional folate supplementation (what it is, why it should be used, how often it should be used, where supplements can be purchased) **Delivery:** Computerized questions and videos, in a semi-private space	**Duration:** 6 **Follow-up r**
5	Pre–post	October 1994–August 1995	Australia	**Criteria:** Southern Australian women aged 15–44 years **Recruitment:** Random digit dialing from Electronic White Pages **Sample size:** 408 before, 401 after **Participation rate:** N/A	**Approach:** Posters and pamphlets **Content:** Information on folate in prevention of neural tube defects **Delivery:** Posted in community health centres, health food stores, shopping centres, libraries, child care centres, schools, pharmacies, doctors' waiting rooms, and hospitals (aimed at public and health professionals)	**Duration:** A immediately intervention **Follow-up r** applicable
7	Pre–post	N/A	US	**Criteria:** College-aged women **Recruitment:** Flyers and TV advertisements on campus **Sample size:** 20 **Participation rate:** 77%	**Approach:** Four 90-minute education sessions **Content:** Reproductive life planning, HIV and STIs, healthy lifestyle choices, maternity care **Delivery:** Women's circle at a small public liberal arts college	**Duration:** 1 **Follow-up r**
	RCT	N/A	US	**Criteria:** Non-pregnant women aged 18–35 years **Recruitment:** Triangular community-based approach in 15 low-income rural communities **Sample size:** 692 **Participation rate:** N/A	**Approach:** Six biweekly two-hour small group sessions over 12 weeks **Content:** Motivation for behavioural changes related to managing stress, nutrition, gynecologic infection, tobacco and alcohol use **Delivery:** Group sessions led by trained facilitators	**Duration:** 2 **Follow-up r**
	Pre–post	October 2009–August 2010	US	**Criteria:** African-American men and women aged 18–30 years **Recruitment:** In the community using flyers **Sample size:** 24 men, 27 women **Participation rate:** N/A	**Approach:** 1) media campaign, 2) community-based presentations, 3) grand rounds for health professionals **Content:** Awareness about life course perspective and general preconception and interconception health, with an emphasis on improving birth outcomes **Delivery:** 1) radio, billboards, flyers, 2) barber and beautician shops frequented by African-American community members, 3) clinical settings (for health professionals)	**Duration:** A immediately post-interven **Follow-up r** applicable
	Quasi-experimental	N/A	US	**Criteria:** Women aged 18–36 years with plan of getting pregnant in next 5 years (excluded individuals working in health field, participating in other research studies) **Recruitment:** Shopping malls **Sample size:** 698 **Participation rate:** N/A	**Approach:** Professionally developed brochures with preconception health messages **Content:** Different combinations of messages on screening for disease, healthy lifestyles, managing and monitoring health **Delivery:** Shopping mall	**Duration:** A immediately post-interven **Follow-up r** applicable
	RCT	N/A	US	**Criteria:** Women aged 18–24 years **Recruitment:** Undergraduate campuses (method N/A) **Sample size:** 295 **Participation rate:** N/A	**Approach:** Health promotion messages, time frame N/A **Content:** Multivitamin information related to beautify, internal health, general health, disease prevention, nutrition, delivered in randomized order **Delivery:** Twitter	**Duration:** 1 **Follow-up r**
2	RCT	N/A	US	**Criteria:** Women aged 18–29 years (excluded women who were pregnant, following diet that restricted vitamins, minerals, or supplements) **Recruitment:** University E-mail system **Sample size:** 468 **Participation rate:** 32%	**Approach:** Four education messages, stage-tailored, one per week for four weeks; education modules **Content:** Folic acid supplementation knowledge and behaviours **Delivery:** Messages delivered by e-mail; website for education modules	**Duration:** 6 **Follow-up r**

Table 1. (Continued)

Study, year	Design	Study period	Location	Population/no. participants	Intervention(s)	Follow-up
Wade 2012[33]	Pre–post	N/A	US	**Criteria:** College students **Recruitment:** Sophomore health promotion nursing course **Sample size:** 53 **Participation rate:** N/A	**Approach:** Education program, including DVD, brochure, risk assessment tool, discussion **Content:** Chronic and genetic conditions, medications, STIs, folic acid, obesity, vaccinations, smoking and alcohol use, social determinants of health (e.g., domestic violence) **Delivery:** By peers in classroom setting	**Duration:** Assessment immediately post-intervention **Follow-up rate:** Not applicable
Watson 2001[34]	RCT	November 1996–April 2000	Australia	**Criteria:** Women aged 15–44 years **Recruitment:** Surveyed as part of population-representative surveys **Sample size:** 1196 before, 1204 (1997) and 1127 (2000) after **Participation rate:** N/A	**Approach:** Printed material including posters, leaflets, and information kits, for four months **Content:** Folic acid supplementation recommendations **Delivery:** Distributed broadly throughout the community (e.g., supermarkets, pharmacies, health centres)	**Duration:** Assessment immediately post-intervention **Follow-up rate:** Not applicable
Williams 2001[35]	Interrupted time series	July 1998–May 1999	Australia	**Criteria:** Women aged 18–44 years **Recruitment:** Selected to be surveyed as part of a stratified random telephone-based sampling process **Sample size:** 1742 **Participation rate:** N/A	**Approach:** Education campaign using general messages in magazine and TV advertisements, for six months; education campaign using specific health claim in magazine and TV advertisements and on cereal packages, for six months **Content:** Folic acid supplementation recommendations **Delivery:** Distributed broadly throughout the community	**Duration:** Assessment immediately post-intervention **Follow-up rate:** Not applicable

Note: ACOG = American College of Obstetricians and Gynecologists; DVD = digital video disc; N/A = not available; RCT = randomized controlled trial; STIs = sexually transmitted infections.

updating vaccinations,[24] increasing physical activity,[28] and reducing smoking and alcohol consumption.[24] All of these studies reported statistically significant positive changes in behaviour. Another study reported on behavioural intentions and did not have any statistically significant results. Finally, one study examined an actual health outcome. This study found a statistically significant decrease in the prevalence of neural tube defects following a folic acid health promotion intervention aimed at both health professionals and the general public, which used posters and pamphlets in public spaces such as community health centres, childcare centres, and schools.[26]

Quality assessment

Using the EPHPP quality assessment tool, the global rating for 11 of the studies was weak (Table 3). One study was rated as moderate;[32] this study was a randomized controlled trial of a folic acid awareness intervention. The most common limitations of the studies were related to selection bias, blinding, data collection methods, and withdrawals and dropouts. The selection bias component of the EPHHP had the highest number of weak ratings (n = 8, 67%)[24,25,27,29–33] due to low (32%–77%) or unreported participation rates, as well as study participants' poor representativeness of the broader target population because of self-referral into the study. A majority of studies also received a weak rating on blinding (n = 7, 58%);[24,27–29,33–35] this was mostly due to study design (e.g., pre–post) and the nature of the interventions, resulting in awareness among both assessors and participants of intervention status. A similar number of studies received a weak rating on data collection methods (n = 7, 58%)[24,26,28–30,34,35] because most authors did not use validated tools or did not report their psychometric properties. Finally, five (42%) of the studies received a weak rating for withdrawals and dropouts because of high attrition (52%–77%) or unreported follow-up rates.[24,25,27,28,31] Only one study that included a follow-up rate reported that over 80% of individuals who started the study completed it.[32]

DISCUSSION

Summary of findings

Our systematic review consisted of 12 studies that examined the effectiveness of preconception health interventions, delivered to individuals of reproductive age in public health and community settings, on reproductive, maternal, and child health outcomes. There was substantial heterogeneity among the included studies in terms of study design, study population, type of intervention, and type of outcome. Only five studies used a randomized controlled trial design, the gold standard for measuring intervention effectiveness. The majority instead adopted quasi-experimental, pre–post, or interrupted time series designs. Most studies examined educational interventions with a single point of contact with participants and no follow-up. Overall, the diverse interventions appeared to have a positive effect on preconception health knowledge, behaviour change, and the specific health outcomes that were targeted. However, the quality of the included studies was weak, and notable gaps in the focus of the studies included a lack of information on the effectiveness of preconception health interventions delivered to men and to LGBTQ (lesbian, gay, bisexual, transgender and queer) populations as well as on

Table 2. Outcomes and results of included studies (n = 12)

Study, year	Outcome(s)	Analysis	Findings	*p* value
Agricola 2014[24]	**Prevalence of risk factors:**	Descriptive differences in		
	No folic acid supplementation	proportions (post-test vs.	−23.4%	<0.001
	BMI < 18.5	pre-test)	−2.5%	0.25
	BMI ≥ 25		3.2%	0.34
	Need rubella vaccination		−13.8%	<0.001
	Need varicella vaccination		−7.4%	0.002
	Need hepatitis B vaccination		−22.3%	<0.001
	Smoking		−7.4%	0.002
	Drinking		−46.4%	<0.001
	Knowledge of risk factors:			
	General preconception behaviours		20.9%	<0.001
	Folic acid supplementation		1.7%	0.24
	Timing of preconception counselling		−7.4%	0.04
	Inheritability of malformations and genetic diseases		−37.2%	<0.001
	Age at risk for Down syndrome		1.4%	0.48
	Maintaining a normal weight		−0.3%	0.78
	Overweight and obesity		−1.4%	0.61
	Underlying maternal diseases		−4.6%	0.15
	Smoking		−0.7%	0.59
	Medications		0.0%	1.00
	Drinking alcohol		3.2%	0.44
	Need of testing for susceptibility to infectious diseases		3.2%	0.25
	Immunization before pregnancy		−6.7%	0.11
Bimla Schwarz 2008[25]	**Knowledge that:**	Relative risk from		
	Folate prevents birth defects	propensity-	1.72 (1.32–2.23)	<0.001
	Folate is important in early pregnancy	score-weighted models,	2.11 (1.50–2.97)	<0.001
	Prevalence of risk factors:	intervention vs. control		
	Recent use of folate supplementation		1.54 (1.12–2.13)	0.01
Chan 2001[26]	**Knowledge of:**	Mantel-Haenszel tests for		
	Sufficient folate in diet prevents spina bifida	differences in proportions	25.5% vs. 41.9%	<0.0001
	Food groups with the most folate	comparing pre- and post-	19.4% vs. 35.5%	<0.0001
	Increase folate before and in first three months of pregnancy	test; Poisson regression	11.5% vs. 28.4%	<0.0001
	Health outcome:	for incidence of neural		
	Incidence of neural tube defects, decline per year	tube defects	1% decline per year	0.03
DeJoy 2014[27]	**Knowledge of:**	Mean score for each		
	Preconception health	composite measure	+1.1 of 6 points	<0.001
	Midwifery care	between pre- and post-	+0.7 of 3 points	0.008
	Risks associated with:	test compared using		
	Childbirth interventions	paired *t* test	+1.0 of 3 points	N/A
Hillemeier 2008[28]	**Self-efficacy:**	GLM or logistic		
	For eating healthy food	regression model,	1.109	0.018
	Preconceptional control	comparing intervention	1.192	0.031
	Behavioural intent:	vs. control		
	To eat healthier foods		1.757	0.008
	To be more physically active		2.185	0.000
	Behaviour change:			
	Reads food labels for nutritional values		2.264	0.001
	Uses daily multivitamin with folic acid		6.595	0.000
	Meets recommended physical activity		1.867	0.019
Hussaini 2013[29]	**Opinions after community presentations (males and females):**	Mean scores, post- vs. pre-test compared using		
	Community perception of problem severity	paired *t* test	3.65 vs. 3.14	<0.01
	Preconception health		3.67 vs. 3.48	<0.01
	Self-perception of positive health behaviours		3.33 vs. 3.16	<0.01
	Self-perception of negative health behaviours		3.17 vs. 2.89	<0.01
	Knowledge of health disparities		1.30 vs. 0.55	<0.01
	Health self-efficacy		3.79 vs. 3.68	<0.01
	Agreement with health statements (females only):			
	Using birth control is an important aspect of health		95.96% vs. 92.69%	N/A
	A father's health decisions will affect the future health of his child		94.41% vs. 93.04%	N/A
	A mother's health decisions will affect the future health of her child		98.72% vs. 96.55%	N/A
	A strong community support network is important for health and well-being		96.89% vs. 93.90%	N/A
	Sexual health is an important aspect of health		96.48% vs. 94.04%	N/A
	Stress is an important factor during pregnancy affecting a baby's future health		94.32% vs. 91.42%	N/A
				N/A
	Agreement with health statements (males only):			N/A
	Using birth control is an important aspect of health		94.59% vs. 93.24%	N/A
	A father's health decisions will affect the future health of his child		94.94% vs. 86.25%	
	A mother's health decisions will affect the future health of her child		97.47% vs. 90.12%	N/A
	A strong community support network is important for health and well-being		89.33% vs. 89.74%	N/A
				N/A
	Sexual health is an important aspect of health		93.42% vs. 93.51%	
	Stress is an important factor during pregnancy affecting a baby's future health		90.91% vs. 85.71%	

Continued

Table 2. (Continued)

Study, year	Outcome(s)	Analysis	Findings	*p* value
King 2013[30]	**Unaided correct recall of health behaviours:**	Mean proportion,		
	For all 15 messages in 3 categories and labelled	intervention vs. control	27.0% vs. 10.7%	<0.05
	For all 15 messages not in categories	group compared using	29.1% vs. 10.7%	<0.05
	For 1 category, 4 messages labelled	ANOVA	58.7% vs. 10.7%	<0.05
	For 4 messages, each from different categories		50.5% vs. 10.7%	<0.05
	For 1 category, 3 messages (labelled)		57.8% vs. 10.7%	<0.05
	For 1 message		58.2% vs. 10.7%	<0.05
	Aided correct recall of health behaviours:			
	For all 15 messages in 3 categories and labelled		49.8% vs. 16.4%	<0.05
	For all 15 messages not in categories		54.0% vs. 16.4%	<0.05
	For 1 category, 4 messages labelled		72.0% vs. 16.4%	<0.05
	For 4 messages, each from different categories		64.4% vs. 16.4%	<0.05
	For 1 category, 3 messages (labelled)		71.5% vs. 16.4%	<0.05
	For 1 message		76.5% vs. 16.4%	<0.05
Mackert 2012[31]	**Beliefs:**	Mean scores, intervention		
	Positive beliefs about multivitamins	vs. control group	5.21 vs. 5.27	0.68
	Attitudes, norms, behavioural control, intentions:	compared using *t* test		
	Positive attitudes about multivitamin intake		5.68 vs. 5.49	0.06
	Subjective norm in support of taking multivitamins		5.43 vs. 5.49	0.09
	Perceived control over multivitamin intake		5.19 vs. 5.07	0.29
	Intentions to take multivitamins		4.56 vs. 4.24	0.09
Milan 2010[32]	**Health behaviours:**	Proportions, intervention		
	Take multivitamin	vs. control group	32.6% vs. 19.9%	0.02
	Began in pre-action, moved to action/maintenance	compared using Chi	22% vs. 10%	N/A
	Began in pre-action, no movement	square tests; mean	33% vs. 55%	<0.001
	Began in contemplation, no movement	scores, intervention vs.	36% vs. 58%	0.005
	Began in pre-action, moved to action	control group compared	32% vs. 17%	0.004
	Self-efficacy:	using *t* tests		
	Self-efficacy		6.02 vs. 1.64	<0.001
	Pros of multivitamin use		1.15 vs. −0.10	0.038
	Cons of multivitamin use		−0.63 vs. −0.59	>0.05
Wade 2012[33]	Preconception health knowledge (measured with an 18 item pre/post test)	Mean scores pre- vs. post-test	72.4 vs. 89.3	0.01
Watson 2001[34]	Role of folate on reduction of risk of neural tube defects	Adjusted odds ratios,	1.24	0.007
	Correct food sources for folate	comparing intervention	1.90	0.06
	Correct timing of taking folate	with control group	1.67	0.07
	Both correct food source and timing		1.73	0.16
	Know of foods with added folate		3.75	0.002
	Correct for added folate, of those who know		2.70	0.03
	Nominate ready-to-eat breakfast cereals with added folate, of those who know		1.55	0.2
	Use correct foods with added folate, of those who know		1.50	0.003
	Do not know what folate is important for		0.33	<0.001
	Know folate is important:			
	To prevent birth defect		2.21	<0.001
	To help in pregnancy		2.80	0.005
	As a vitamin or nutrient		2.27	0.002
	To do with iron/blood/anemia		0.98	0.5
	To do with healthy bones		1.18	0.4
Williams 2001[35]	Aware of folate	Proportions at baseline	63% vs. 72% vs. 84%	<0.05
	Aware of recommendation to increase folate before pregnancy	vs. after intervention 1 vs.	37% vs. 45% vs. 67%	<0.05
	Nominating foods as sources of folate, unprompted:	after intervention 2		
	Leafy green vegetables		29% vs. 33% vs. 41%	<0.05
	Breakfast cereals		17% vs. 26% vs. 37%	<0.05
	Fruit		7% vs. 12% vs. 11%	<0.05
	Bread		5% vs. 6% vs. 10%	<0.05
	Meat		9% vs. 8% vs. 9%	≥0.05
	Fish		1% vs. 3% vs. 2%	≥0.05
	Cheese		5% vs. 4% vs. 6%	≥0.05
	Believe folate reduces disease risk:			≥0.05
	Heart disease		6% vs. 3% vs. 3%	
	Cancer		5% vs. 3% vs. 4%	≥0.05
	Spina bifida		13% vs. 15% vs. 20%	<0.05
	Birth defects		21% vs. 29% vs. 44%	<0.05

Note: ANOVA = analysis of variance; BMI = body mass index; N/A = not available.

interventions targeting broader preconception health determinants, such as mental health and environmental exposures.

Comparison with previous research

Our study contributes to the literature by systematically evaluating the effectiveness of preconception health interventions delivered outside of clinical settings (i.e., in public health and community settings). Such an evaluation is critical, given the wide scope of preconception health, the high rate of unplanned pregnancies,[13] and the barriers experienced by some population groups (e.g., recent immigrants and those of low socio-economic status) in accessing clinical care.[36,37] To our knowledge, three previous systematic reviews have evaluated the effectiveness of

Table 3. Quality appraisal of included studies (n = 12)

Study, year	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals/dropouts	Global rating
Agricola 2014[24]	Weak	Moderate	Strong	Weak	Weak	Weak	Weak
Bimla Schwarz 2008[25]	Weak	Strong	Weak	Moderate	Moderate	Weak	Weak
Chan 2001[26]	Moderate	Moderate	Weak	Moderate	Weak	Strong	Weak
DeJoy 2014[27]	Weak	Moderate	Strong	Weak	Moderate	Weak	Weak
Hillemeier 2008[28]	Moderate	Strong	Strong	Weak	Weak	Weak	Weak
Hussaini 2013[29]	Weak	Moderate	Strong	Weak	Weak	Weak	Weak
King 2013[30]	Weak	Strong	Weak	Moderate	Weak	Moderate	Weak
Mackert 2012[31]	Weak	Strong	Weak	Strong	Moderate	Weak	Weak
Milan 2010[32]	Weak	Strong	Strong	Strong	Strong	Strong	Moderate
Wade 2012[33]	Weak	Moderate	Strong	Weak	Moderate	Moderate	Weak
Watson 2001[34]	Moderate	Strong	Strong	Weak	Weak	Moderate	Weak
Williams 2001[35]	Moderate	Moderate	Weak	Weak	Weak	Moderate	Weak

preconception health interventions on reproductive, maternal, and child health outcomes.[20,22,38] Unlike our review, they included studies that were conducted mainly among women in clinical settings such as primary care, obstetrics or midwifery, and urgent care.

The earliest of these reviews was conducted by Korenbrot et al.[22] The authors identified 19 randomized controlled trials, quasi-experimental studies, and pre–post studies published between January 1990 and July 1999. Interventions, conducted mainly in hospital settings, were education sessions, diet supplementation, and nutritional counselling. The authors found some evidence of improved uptake of screening for risk conditions, folate supplement use among sexually active women, and nutrition quality among women with specific metabolic conditions (e.g., diabetes, phenylalanemia). However, the quality of included studies was not systematically evaluated. A Cochrane systematic review and meta-analysis was conducted by Witworth and Dowswell.[38] After excluding studies with a high risk of bias, the authors identified only four randomized controlled trials and quasi-experimental studies of preconception health interventions published before February 2009. Interventions were education sessions delivered across one or multiple time points in clinical settings. In the meta-analysis, the authors found no effect of these interventions on preterm birth, weight for gestational age, or congenital anomalies. Most recently, a systematic review by Hussein et al.[20] evaluated eight randomized controlled trials published between July 1999 and July 2015. Interventions, mainly education sessions, counselling, and health risk assessments, were delivered in general clinical practices, gynecology outpatient clinics, or women and infant clinics, or during home visits by midwives. Generally, the authors found a positive effect of the interventions on knowledge increase and behaviour change as well as self-efficacy and health locus of control. The quality of included studies was rated as weak or moderate. As shown by the variable findings and quality of the existing literature, there is a need for rigorous research in this area across diverse health care settings.

Limitations

Our ability to provide practice recommendations about the effectiveness of preconception health interventions delivered to all individuals in public health and community settings is limited by the quality of the studies included in the review. Given the small number of studies on the topic, we included both randomized controlled trials and other, weaker, interventional study designs, including quasi-experimental, pre–post, and interrupted time series designs. These latter designs are more vulnerable to confounding than randomized controlled trials, either because of differences between intervention and control groups (e.g., for quasi-experimental designs) or because of changes in health behaviours or population characteristics across time (e.g., for pre–post or time series designs).[39] Therefore, it is more difficult to attribute changes in knowledge, behaviour, or health outcomes to the intervention itself as opposed to these underlying differences.

Although implementation of randomized controlled trials in public health and community settings can be difficult, high-quality research is needed so that the effectiveness of interventions can be evaluated. Upon assessment, all included studies except one were given a "weak" quality rating. A common limitation of the studies was selection bias. Of the studies that provided information on participation rates, between 32% and 77% of individuals approached agreed to participate. Similarly, many studies with follow-up periods reported high rates of withdrawal from studies, with follow-up rates of only 52% to 77%. Collectively, low participation rates and high attrition make it possible that included participants were not representative of the broader population. Moreover, half of the included studies had no follow-up beyond the immediate study period, leaving it unclear whether interventions had a lasting, meaningful impact. Finally, few studies used validated outcome assessments, and only a handful of studies reported piloting their questionnaire before study implementation. The one moderate-quality study was a randomized controlled trial of a folic acid intervention.[32] While promotion of folic acid supplementation certainly warrants attention, there is a need for evaluation of interventions that address other risk factors and take a much broader approach to preconception health.

While the literature surveyed in our review does not necessarily represent all interventions being practised, formal evaluation of interventions is critical; as stated in the Select Panel on Preconception Care of the US Centers for Disease Control and Prevention, there is clearly a need to "increase the evidence-base for preconception health and promote use of evidence in delivering preconception health".[40]

Implications

Our review highlights several areas that warrant further research. As demonstrated by our findings, most of the interventions to date have been targeted at women. Ontario data from the Best Start Resource Centre survey of reproductive-aged women and men showed gaps in understanding of the man's contribution to the health of a pregnancy and baby.[41] The World Health Organization recommends that men should be active partners in preconception health promotion and care.[3] Yet, few preconception health risk assessments, screening programs, or education initiatives include or target men. There is also a paucity of research including LGBTQ populations.[18] There is a need to design inclusive preconception health interventions that are accessible for all individuals of reproductive age, regardless of their gender identity, gender expression, or sexual orientation, including those planning and not planning a pregnancy.

Most interventions focused on medical and lifestyle determinants of preconception health (e.g., nutrition, immunization, physical activity, and lifestyle behaviours) aimed at the individual, and there was a particular emphasis on folic acid interventions. While such interventions are important, there was a lack of information on interventions targeting mental health and environmental exposures. Mental illness is the most common cause of disability in women and men,[42] and there is evidence that maternal and paternal mental illness affects infant outcomes.[43] Environmental hazards, such as living near industrial or landfill sites or exposure to plastics (e.g., phthalates), are increasingly being recognized as risk factors for poor perinatal outcomes.[44] There is a clear need for high-quality research evaluating the effectiveness of preconception health interventions that address the broad determinants of preconception health; many of these determinants (e.g., environmental exposures) may require community- and population-level action.

To move beyond this narrow focus, preconception health promotion and care within a public health context should adopt a health equity lens. This perspective is based on a broad socio-environmental approach that shifts the responsibility for preconception health from the individual level alone to the community and system levels as well.[18] Such an approach highlights the roles of the social determinants of health, including income, employment, and social connectedness, which are known to have an impact on birth outcomes (e.g., preterm birth)[45] and also recognizes that many upstream social determinants of health are complex and involve factors outside of an individual's control (e.g., affordable housing).[46] A health equity approach to preconception health promotion and care is consistent with the Ontario Public Health Standards[19] and requires greater political awareness and support for preconception health. In Ontario, reproductive health is a recognized component of the mandates of the Ministry of Health and Long-Term Care and the Ministry of Children and Youth Services; however, a focus on preconception health is lacking.[18] Political momentum is needed to develop a comprehensive, standardized approach to preconception health promotion and care in Canada.

It is notable that all included studies were conducted outside of Canada (i.e., the US, Australia and Italy). It is likely that the social and health context of these studies affected their results. It is unclear to what extent results may be generalizable to the Canadian context. There is a real need for assessment of preconception health promotion and care interventions delivered and evaluated in Canada.

CONCLUSION

There is growing evidence that preconception health interventions, delivered to women and men in public health and community settings, improves health knowledge, behaviour change, and health outcomes. However, the methodological quality of existing research is poor, and there is a lack of information on interventions appropriate for men and LGBTQ populations. Further, no studies have targeted the broader determinants of preconception health, including mental health and environmental exposures. Future research should consider adopting a health equity lens that considers the broader socio-environmental determinants of preconception health and includes all individuals.

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RÉSUMÉ

OBJECTIFS : Cette revue systématique vise à évaluer les effets d'interventions sanitaires préconceptionnelles, menées auprès de personnes en âge de procréer dans des contextes communautaires et de santé publique, sur les résultats de santé reproductive, maternelle et infantile.

MÉTHODE : Nous avons interrogé les bases de données Ovid MEDLINE, CINAHL, EMBASE, PsychINFO, Scopus, Gender Studies Database et SocINDEX entre juillet 1999 et juillet 2016. Nous avons inclus les études faisant état de données originales, utilisant un plan d'étude interventionnelle, incluant des femmes ou des hommes en âge de procréer, rédigées en anglais et parues dans des revues à comité de lecture. Deux évaluatrices ont utilisé de façon indépendante des instruments normalisés pour extraire les données et en évaluer la qualité. Une synthèse narrative a été effectuée.

SYNTHÈSE : Douze études ont répondu aux critères d'inclusion. Il s'agissait d'essais comparatifs randomisés, de démarches quasi expérimentales, d'études avant/après et d'analyses de séries chronologiques. La plupart avaient été menées aux États-Unis; toutes sauf une n'incluaient que des femmes. Les interventions étaient principalement des initiatives pédagogiques axées sur la nutrition, la vaccination et les comportements liés au mode de vie, et elles avaient été menées en un seul contact. Les études ont fait état d'effets positifs sur les connaissances en santé ($n = 9$), sur les changements de comportements ($n = 4$) et sur les résultats de santé ($n = 1$). Leur qualité était faible ($n = 11$) ou modérée ($n = 1$), avec des contraintes liées au biais de sélection, à l'insu, aux méthodes de collecte de données et à l'attrition des participant(e)s.

CONCLUSION : Pour élaborer une méthode globale et normalisée d'aborder la promotion de la santé et les soins préconceptionnels au Canada, il est clairement nécessaire d'avoir des études de haute qualité qui évaluent l'efficacité des interventions sanitaires préconceptionnelles. Ces études devraient utiliser un prisme d'équité en santé qui inclut toutes les personnes en âge de procréer et qui aborde les grands déterminants de la santé préconceptionnelle.

MOTS CLÉS : Promotion de la santé; prise en charge préconceptionnelle; santé publique