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Barriers and enablers to a healthy lifestyle in people with infertility: a mixed-methods systematic review

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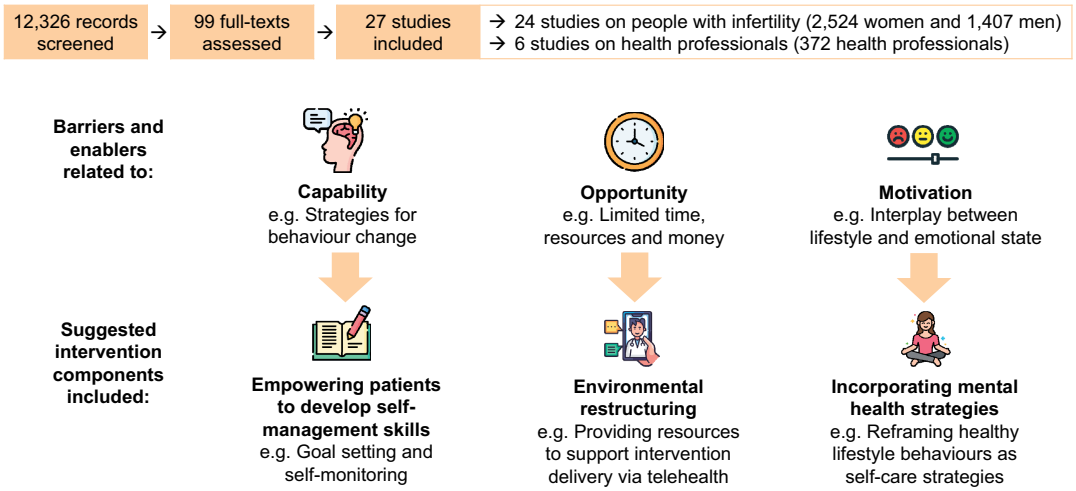
GRAPHICAL ABSTRACT



Several interacting factors influence lifestyle management of infertility, and these factors can be targeted to optimize interventions.

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ABSTRACT

BACKGROUND: While there is a recognized role of optimizing lifestyle (diet and physical activity) behaviours in the management of infertility, the best practice remains unknown and factors influencing the lifestyle of people with infertility are not well understood.

OBJECTIVE AND RATIONALE: This systematic review evaluated barriers and enablers to a healthy lifestyle in people with infertility, from the perspectives of people with infertility and health professionals, in order to inform optimal behavioural change strategies.

SEARCH METHODS: Ovid MEDLINE(R), PsycINFO, EMBASE, EBM Reviews, and CINAHL were searched from inception to 28 August 2023. Eligible studies were qualitative and quantitative primary studies that explored barriers and/or enablers to lifestyle for infertility management. Quality assessment was performed using the Centre for Evidence-Based Management Critical Appraisal of a Survey Tool and the Critical Appraisal Skills Programme Qualitative Checklist. Data were analysed by thematic analysis with themes mapped to the Capability, Opportunity, Motivation and Behaviour (COM-B) model and Theoretical Domains Framework (TDF).

OUTCOMES: After screening 12 326 abstracts and 99 full-texts, 27 studies were included (12 quantitative, 6 qualitative and 9 mixed-methods) with 22 studies of women with infertility (n = 2524), 11 studies of men with infertility (n = 1407), and 6 studies of health professionals (n = 372). We identified barriers and enablers relating to capability (e.g. strategies for behaviour change), opportunity (e.g. limited time, resources, and money), and motivation (e.g. interplay between lifestyle and emotional state). Based on the identified themes, suggested intervention components to integrate into lifestyle management of infertility include facilitating development of self-management skills to support lifestyle change (e.g. self-monitoring, action planning, and goal setting) and incorporating mental health strategies (e.g. providing information about the benefits of healthy lifestyle behaviours for mental health and encouraging patients to reframe healthy lifestyle behaviours as self-care strategies).

WIDER IMPLICATIONS: The findings have identified important factors that influence lifestyle management in people with infertility and have suggested relevant intervention components to consider when designing interventions. Given the paucity of qualitative studies identified, more research is needed to further understand the complex and interacting factors that shape lifestyle during the fertility journey.

Keywords: COM-B model / lifestyle behaviours / infertility / Theoretical Domains Framework / diet / exercise

Introduction

Infertility, defined as the inability to achieve a clinical pregnancy after 12 months of regular, unprotected sexual intercourse, affects up to 186 million individuals globally (Inhorn and Patrizio, 2015; Zegers-Hochschild *et al.*, 2017). Couples with infertility experience increased psychological stress and reduced quality of life (Chachamovich *et al.*, 2010; Greil *et al.*, 2011). Existing medical treatments for infertility have significant physical, psychological, and financial burdens, which could lead to treatment discontinuation before achieving a live birth (Gameiro *et al.*, 2012). Additionally, the live birth rate per cycle of IVF is ∼25–40% (Chambers *et al.*, 2021), highlighting a crucial need to investigate the role of modifiable factors that can influence fertility. A healthy lifestyle is recommended in multiple clinical guidelines for infertility (Practice Committee of the American Society for Reproductive Medicine and the Practice Committee of the Society for Reproductive Endocrinology and Infertility, 2022; Romualdi *et al.*, 2023; Teede *et al.*, 2023).

Preconception lifestyle factors positively associated with improved fertility outcomes following ART include optimal physical activity (Rao *et al.*, 2018) and diet (Kellow *et al.*, 2022; Sanderman *et al.*, 2022; Alesi *et al.*, 2023; Winter *et al.*, 2023) and having a BMI within the healthy weight range (Oostingh *et al.*, 2019; Purewal *et al.*, 2019; Sermondade *et al.*, 2019). Conversely, preconception lifestyle factors, which decrease fertility include tobacco use and heavy alcohol use (Augood *et al.*, 1998; Oostingh *et al.*, 2019). To support the development of successful lifestyle interventions for infertility, there is a need to examine factors influencing the lifestyle behaviours of people living with infertility and understand perspectives of health professionals working in infertility management. People with infertility experience unique challenges during the preconception period. There is a widespread use and interest in adjuncts to fertility treatment, including lifestyle management, to aid conception (Vincent and Furnham, 1996; Smith *et al.*, 2010). However, time, financial, and mental health impacts of fertility treatment may reduce the capacity of individuals to engage in healthy lifestyle behaviours (Gameiro *et al.*, 2012; Wu *et al.*, 2013). Health professionals working in fertility clinics also experience multiple stressors including a high workload and concerns about patient expectations of care (Boivin *et al.*, 2017), as potential barriers to effectively promoting lifestyle management. No previous systematic reviews have examined barriers and enablers to lifestyle change in people with infertility from the perspectives of people with infertility and health professionals. Understanding these barriers and enablers ensures a targeted approach that can optimize intervention effectiveness.

The Behaviour Change Wheel (BCW) is a systematic and evidence-based method used to ensure interventions address key barriers and enablers (Michie *et al.*, 2011). In the BCW method, barriers and enablers are classified using the Capability, Opportunity, Motivation and Behaviour (COM-B) model, which considers the individual and contextual factors shaping behaviours and posits that behaviours are influenced by three interacting components: capability, opportunity, and motivation (Michie *et al.*, 2011). The Theoretical Domains Framework (TDF) further subdivides each component of the COM-B model and consists of 14 domains (Atkins *et al.*, 2017). Behaviour change is then elicited via behaviour change techniques (BCTs) mapped to these domains (Michie *et al.*, 2013). Analysing barriers and enablers to lifestyle change using these frameworks allows for the systematic development of suitable interventions (Michie *et al.*, 2011).

The aim of this mixed-methods systematic review was to evaluate barriers and enablers to lifestyle change in people with infertility, from perspectives of people with infertility and health care professionals, using the COM-B model and TDF in order to inform optimal behavioural change strategies.

Methods

This review was prospectively registered in the Prospective Register of Systematic Reviews (PROSPERO) (CRD42022359424) and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page *et al.*, 2021) and the Enhancing transparency in reporting

the synthesis of qualitative research (ENTREQ) statement (Tong *et al.*, 2012).

Search strategy

A comprehensive search strategy was developed utilizing free-text words and subject headings. The following databases were searched from inception to 28 August 2023: Ovid MEDLINE(R), PsycINFO, EMBASE, and EBM Reviews. CINAHL Plus was searched from inception to 12 September 2022 and CINAHL Complete was searched from 12 September 2022 to 28 August 2023, due to an upgrade in our access. The search strategy reflected three key concepts: eligible populations (terms related to infertility), eligible interventions (terms related to lifestyle interventions, defined as diet, physical activity, and/or behavioural interventions), and eligible outcomes (terms related to barriers, enablers, experiences, and/or perceptions). Search terms within the same concept were combined using the 'or' Boolean operator, and the three concepts were combined using the 'and' Boolean operator. The full search strategy is available in Supplementary Table S1. Additional methods of study identification included expert referral and handsearching of references of included studies and relevant systematic reviews.

Study selection

Details of inclusion and exclusion criteria are available in Supplementary Table S2. Studies were eligible if they reported on barriers, enablers, experiences, and/or perceptions in relation to lifestyle change in people with infertility from perspectives of people with infertility and/or health professionals involved in infertility management. Qualitative, quantitative, and mixed-methods primary studies were eligible in any language. Narrative reviews, letters, editorials, commentaries, and systematic reviews were ineligible. Conference abstracts were only included if raw data were available from study authors. For studies published as conference abstracts only, or with insufficient information to determine eligibility, study authors were contacted via email once to request further information. If sufficient information to determine eligibility remained unavailable, the study was not included and categorized as 'Awaiting Classification'. All screening was performed by two independent reviewers with this distributed among seven reviewers for title and abstract (D.B., K. L., L.M., L.Z, S.C., S.T., and W.X.) and four reviewers for full-text screening (D.B., S.C., S.T., and W.X.). Eligibility assessment was performed using Covidence. Conflicts were resolved by discussion until consensus was achieved.

Quality assessment

For qualitative studies, the Critical Appraisal Skills Programme (CASP) Qualitative Checklist was used for quality assessment (Critical Appraisal Skills Programme, 2018). For quantitative studies, the Centre for Evidence-Based Management (CEBMa) critical appraisal of a survey tool was used (Center for Evidence Based Management, 2014), regardless of study design. The use of this tool for all quantitative studies allowed for comparison between studies and was deemed suitable because our review did not aim to examine intervention effects. Both tools prompt evaluation of both internal and external validity, and facilitate appraisal of methodological quality and transparency of reporting. For all studies, quality assessment was performed by two independent reviewers (S.T. for all studies and L.Z, K.L, or W.X as the second reviewer). Discrepancies were resolved by discussion or referral to a third reviewer (L.M.). Studies were assessed as low quality if they met <65% of the criteria, moderate quality if they met 65–90%, and high quality if they met >90%. Although CASP and CEMBa do not assign a scoring system for these quality assessment tools, our scoring system is similar to prior systematic reviews that used these tools (Goossens *et al.*, 2018; Njau *et al.*, 2019).

Data extraction

Data were extracted from all included English language studies by one reviewer (S.T.) with verification by two reviewers (L.M. and S.C.). For the two included studies published in Chinese, data were extracted by two reviewers (K.L. and S.T.). Data extracted included author, year of publication, country, setting, study type, data collection method, aims, sample size, inclusion criteria, exclusion criteria, response rate and participant demographic characteristics.

Data analysis and synthesis

Data analyses were conducted using the convergent integrated approach to mixed-methods systematic reviews (Stern *et al.*, 2020), by which quantitative data that answered the review question were first converted to textual descriptions and then analysed along with qualitative data. This approach to developing a preliminary synthesis of data is used to explore relationships across and between different studies with different methodology (Popay *et al.*, 2006; Stern *et al.*, 2020). The results section of qualitative studies and textualized data from quantitative and mixed-methods studies were imported into NVivo 20.3 and thematically synthesized according to previously published methods for systematic reviews of qualitative research (Thomas and Harden, 2008). Codes were inductively generated, organized, and refined until subthemes and themes emerged through an iterative process. Perspectives of people with infertility and health professionals were analysed and presented separately.

Themes were deductively mapped and tabulated to the COM-B and TDF and intervention functions and policy categories as guided by the BCW (Michie *et al.*, 2011; Atkins *et al.*, 2017). Three reviewers (S.T., S.C., and L.M.) worked collaboratively in data analysis and mapping of themes. The identified themes were discussed and agreed upon by all reviewers. Any discrepancies over mapping of themes to domains were resolved by discussion. All three reviewers were dietitians and two were experienced qualitative researchers (S.C. and L.M.). Suggested intervention components were developed in accordance with corresponding intervention functions and policy categories.

Results

The study selection process is illustrated in Fig. 1. The database searches returned 15 986 records; after the removal of 3660 duplicates, 12 326 titles and abstracts and 99 full-texts were screened. Finally, 27 studies (28 reports) were included (25 studies published in English and 2 studies in Chinese). Two studies were published as conference abstracts (Simon *et al.*, 2013; Uraz *et al.*, 2019) and unpublished data provided by study authors were included. Exclusion reasons and citations for studies excluded based on full-text are presented in Supplementary Table S3.

Study characteristics

Characteristics of included studies are presented in Table 1, and detailed information on demographic characteristics of participants are presented in Supplementary Tables S4 and S5. Of the included studies, 12 were quantitative, 6 were qualitative, and 9 were mixed-methods. There were 22 studies that reported on perspectives of women with infertility (n = 2524) and 11 studies

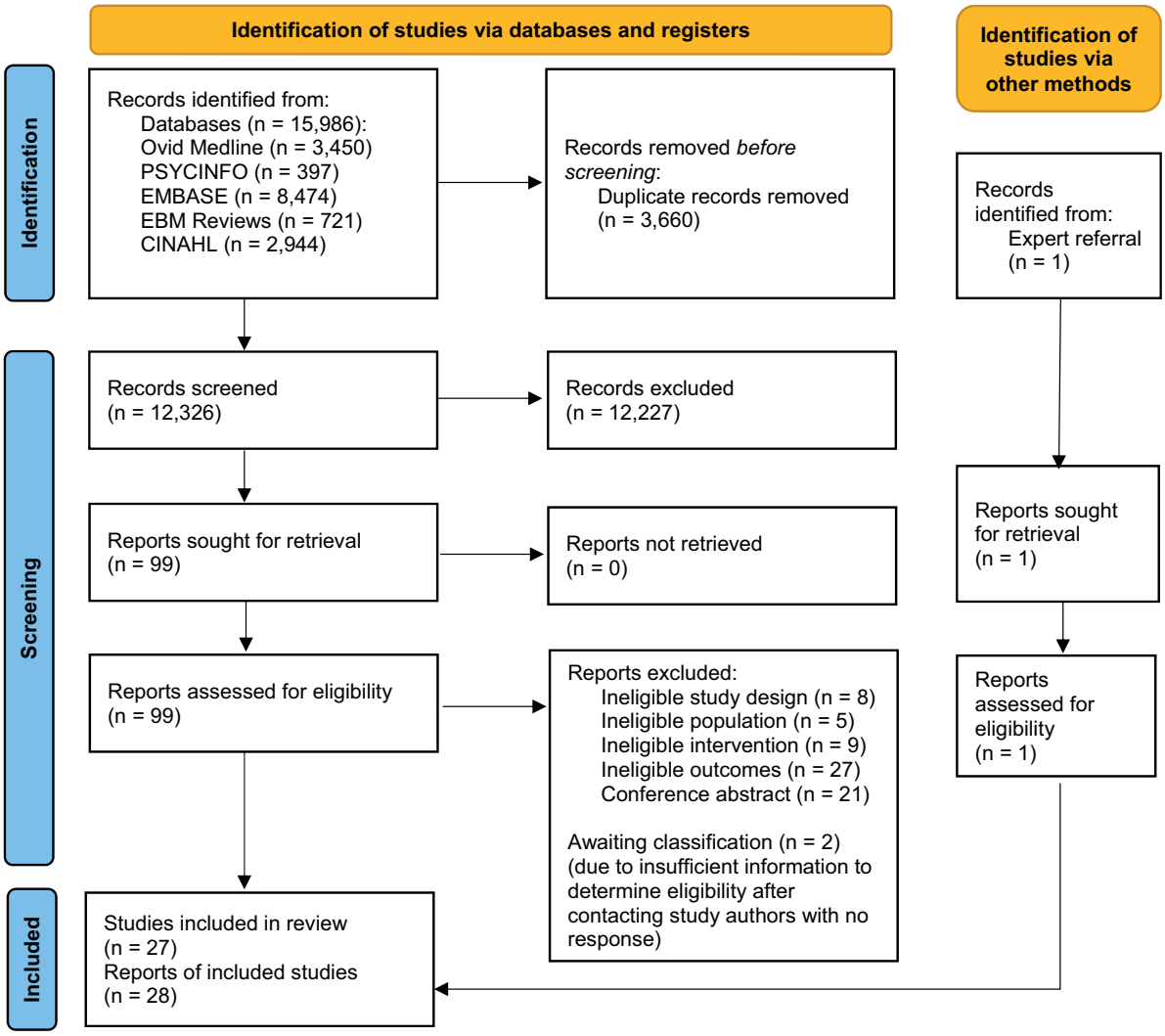

Figure 1. Flowchart of study selection.

that reported on perspectives of men with infertility (n = 1407), while 6 studies reported on perspectives of health professionals (n = 372), of whom the majority were medical doctors (n = 224, 60%) or nurses/midwives (n = 115, 31%).

Quality assessment

Details of quality assessment are shown in Supplementary Tables S6 and S7. Overall, the study quality was low to moderate. Of the 15 qualitative and mixed-methods studies: all had a clear statement of aims and appropriate selection of a qualitative methodology, but none adequately considered the relationship between the researcher and participant. Of the 21 quantitative and mixed-methods studies, all had a clear research question and appropriate study design, but less than half used valid and reliable surveys (8/21), had a representative sample (6/21), or based their sample size on power calculations (4/21).

Themes on barriers and enablers to a healthy lifestyle during infertility, from the perspectives of people with infertility and health professionals

Thematic analysis identified 17 themes for both patients and health professionals, mapped to 5 COM-B components and 12 TDF domains (Table 2). Detailed information on themes, subthemes, supporting examples, and data sources (relative contribution of quantitative and qualitative data) are provided in Supplementary Tables S8 and S9.

Themes relating to capability

Varying levels of understanding of the relationship between lifestyle and fertility

The majority of people with infertility were aware that unhealthy diet (Homan and Norman, 2009), physical inactivity (Jayasena *et al.*, 2020; Gundimi *et al.*, 2022), and having a BMI outside the healthy weight range (Homan and Norman, 2009) were risk factors for infertility. They were also aware of the adverse effects of having an elevated BMI on fertility outcomes (Cardozo *et al.*, 2012; Jayasena *et al.*, 2020; Gundimi *et al.*, 2022), and could self-identify when their BMI was above the healthy range (Homan and Norman, 2009; Cardozo *et al.*, 2012). Conversely, people at or below a healthy weight experienced weight misperception overestimating their BMI category (Homan and Norman, 2009; Cardozo *et al.*, 2012). Level of education was also a barrier to understanding the role of lifestyle in fertility management; those with a lower level of education struggled to identify the relationship between high BMI and decreased fertility (Cardozo *et al.*, 2012; Jayasena *et al.*, 2020). Overall, people were interested in learning more about the role of diet and physical activity in the fertility journey (Vause *et al.*, 2009; Uraz *et al.*, 2019; Jayasena *et al.*, 2020; Boedt *et al.*, 2021; Dreischor *et al.*, 2022; Latifi *et al.*,

Table 1. Characteristics of included studies.

Population	Authors and year	Country	Study type	Data collection methods	Sample (n)
People with infertility only	Boedt 2021	Belgium	Mixed-methods	Quantitative: cross-sectional surveys Qualitative: in-depth interviews.	Women (14) and men (3) with infertility undergoing IVF[a]
	Cardozo 2012	USA	Quantitative	Surveys	Women (150) with infertility attending a fertility clinic
	Claydon 2022	USA	Qualitative	Interviews	Women (7) with infertility with current or previous IVF use
	Dreischor 2022	Belgium and The Netherlands	Qualitative	In-depth interviews	Heterosexual couples (10) and women (2) with infertility who were attempting natural conception after a fertility work-up
	Gundimi 2022	India	Quantitative	Surveys	Women (332) with infertility who have not used ART
	Homan 2009	Australia	Mixed-methods	Structured interviews	Heterosexual couples (10) attending a fertility clinic
	Homan 2012	Australia	Quantitative	Surveys	Heterosexual couples (23) attending a fertility clinic
	Jayasena 2020	UK	Quantitative	Surveys	Men (1149) attending a hospital andrology department for infertility investigation
	Karsten 2019	The Netherlands	Quantitative	Surveys	Women (289) with infertility and BMI ≥29 kg m^{-2} who were randomized to the intervention group of the LIFEstyle RCT
	Klobodu 2023	USA	Mixed-methods	Quantitative: surveys Qualitative: in-depth interviews	Women (5) with infertility who had completed cancer treatment at least 6 months before the study and had resumed menstruation[a]
	Latifi 2022	Iran	Qualitative	Semi-structured interviews	Heterosexual couples (25) with primary infertility undergoing ART
	Li 2017	China	Quantitative	Surveys	Women (573) with infertility attending their first appointment at a hospital fertility clinic
	Liu 2020	China	Quantitative	Surveys	Men (120) with male-factor infertility
	Oron 2015	Canada	Mixed-methods	Quantitative: Surveys Qualitative: NR	Women (49) scheduled to begin IVF at a public fertility clinic
	Porter 2008	UK	Qualitative	In-depth interviews	Heterosexual couples (25) attending a hospital fertility clinic for the first time
	Read 2014	Canada	Qualitative	Dyadic interviews	Heterosexual couples (32) seeking medical treatment for infertility
	Riggan 2023	USA	Qualitative	In-depth interviews	Women (40) with infertility and BMI ≥35 kg m^{-2} seeking fertility treatment
	Sacha 2018	USA	Quantitative	Surveys	Women (148) with infertility attending a hospital fertility centre
	Simon 2013	USA	Quantitative	Surveys	Women (9) with infertility and BMI ≥27 kg m^{-2} attending a fertility clinic
	Uraz 2019	Canada	Mixed-methods	Surveys	Women (13) and men (6) with infertility attending a fertility clinic
	Vause 2009	Canada	Quantitative	Surveys	Women (400) with infertility presenting to a university fertility clinic for the first time
People with infertility and health professionals	Langarizadeh 2022	Iran	Quantitative	Surveys	Women (220) with infertility who had undergone at least 3 months of fertility treatment, nutritionists (10) and infertility specialists (5)
	Ockhuijsen 2012	The Netherlands	Mixed-methods	Surveys	Women (130) on the waiting list for ART and nurses (7) working in a preconception clinic for these women
	Van Dijk 2017	The Netherlands	Mixed-methods	Quantitative: cross-sectional surveys Qualitative: focus groups.	Women (18) and men (4) with an indication for ART[a] + health professionals (9) (gynaecologist (1), midwife (1), general practitioner (1), fertility doctor (1), preventive health care centre physician (1), dietitian (1), medical advisor from a health insurance company (1), representative of the municipality of Rotterdam (1), and representative of the Dutch association of parent and patient organizations (1))
Health professionals only	Boedt 2023	Belgium	Mixed-methods	Surveys	Health professionals (111) (nurses/midwives (50), gynaecologists (42), embryologists (13), psychologists (4), scientists (2)) who interact with patients and work in registered Belgian fertility clinics
	Homan 2018	Australia	Mixed-methods	Surveys	Nurses (53) who manage IVF clinics
	Roberts 2020	USA	Quantitative	Surveys	Obstetrics and gynaecology residents (177)

NR, not reported.
[a] Sample characteristics are from the subset of the study sample, which provided data relevant to our review question.

Table 2. Themes on barriers and enablers to a healthy lifestyle in people with infertility, from the perspectives of people with infertility and health professionals.

COM-B		People with infertility	Health professionals
Capability	Psychological	Varying levels of understanding of the relationship between lifestyle and fertility (B, E)[a,b] Strategies for behaviour change (B, E)[a,b]	Health professionals' knowledge, skills and training (B, E)[a,b] Health professional identification of appropriate content and recipients for lifestyle education (B, E)[a,b]
Opportunity	Physical	Limited time, resources, and money (B)[a,b] Mode of delivery (B, E)[a,b] Reshaping the food environment (B, E)[a,b] Unmet needs from health professional led lifestyle advice (B)[b]	
	Social	Support from partner, peers, and health professionals (B, E)[a,b] Catering for others (B)[a]	
Motivation	Reflective	Understanding the importance and consequences of lifestyle change (B, E)[a,b] Confidence in skills required to follow a healthy lifestyle (B, E)[a,b] Considering the stage of change (B)[a,b]	Belief that patients do not want health professional-led lifestyle education (B)[b] Professional responsibility (B, E)[a,b]
	Automatic	Interplay between lifestyle and emotional state (B, E)[a,b]	Providing lifestyle intervention is rewarding (E)[b]

B, barriers; COM-B, Capability, Opportunity, Motivation and Behaviour; E, enablers.
[a] Quantitative data contributed to this theme.
[b] Qualitative data contributed to this theme.

2022). Topics of interest included foods to improve fertility (Boedt *et al.*, 2021; Latifi *et al.*, 2022) and contraindications of physical activity during fertility treatment (Boedt *et al.*, 2021; Latifi *et al.*, 2022).

Health professionals' knowledge, skills, and training

Varying levels of confidence amongst health professionals in supporting patients to improve lifestyle were seen as a major barrier. While nurses felt they had insufficient skills to facilitate meaningful change in patients with low motivation (Ockhuijsen *et al.*, 2012), their confidence levels improved following adequate training (Ockhuijsen *et al.*, 2012). Health professional awareness of lifestyle risk factors for infertility was an important enabler, with almost all obstetrics and gynaecology residents correctly identifying underweight and obesity as infertility risk factors (Roberts *et al.*, 2020).

Strategies for behaviour change

People with infertility identified difficulty in breaking unhealthy habits as a barrier to making lifestyle changes (Homan *et al.*, 2012). Strategies for behaviour change such as self-monitoring (e.g. via calorie-counting applications) and action planning (e.g. by documenting plans to change habits) supported people with infertility in adhering to a healthy lifestyle (Van Dijk *et al.*, 2017; Sacha *et al.*, 2018; Uraz *et al.*, 2019).

Health professional identification of appropriate content and recipients for lifestyle education

Barriers to the provision of optimal lifestyle management include differing perceptions from nurses regarding which patients may benefit from lifestyle interventions (Homan *et al.*, 2018) and the emphasis on weight, rather than diet and exercise, in fertility management (Boedt *et al.*, 2023). Nurses considered lifestyle counselling important for people with multiple lifestyle risk factors, and lower intensity interventions (e.g. written information or telephone availability) sufficient in other cases (Ockhuijsen *et al.*, 2012), highlighting the potential for provision of target care. Provision by nurses of lifestyle education as a routine practice could potentially enable them to establish consistent routines for care (Homan *et al.*, 2018).

Themes relating to opportunity

Reshaping the food environment

Women with infertility described barriers to following a healthy diet including external food cues, such as the sight and smell of food increasing their susceptibility to eating unhealthy foods or overeating (Karsten *et al.*, 2019), and the external food environment, such as limited availability of healthy foods and hesitancy to visit grocery stores during COVID-19 pandemic (Claydon *et al.*, 2022). Women adapted during the COVID-19 pandemic by using grocery delivery services and bulk-buying foods to reduce the frequency of their grocery store visits (Claydon *et al.*, 2022).

Limited time, resources, and money

People with infertility cited time constraints (Homan and Norman, 2009; Homan *et al.*, 2012; Simon *et al.*, 2013; Uraz *et al.*, 2019; Gundimi *et al.*, 2022), limited finances (Homan and Norman, 2009), and lack of exercise facilities (Gundimi *et al.*, 2022) as barriers to a healthy lifestyle. Similarly, health professionals working in fertility clinics cited time constraints and lack of resource allocation from health organizations as reasons for not providing lifestyle modification programmes (Homan *et al.*, 2018; Boedt *et al.*, 2023). Some nurses also doubted the cost-effectiveness of providing lifestyle modification programmes (Homan *et al.*, 2018).

Unmet needs from health professional-led lifestyle advice

People with infertility did not receive health professional-led lifestyle advice that met their needs. They felt nutrition services were not adequately integrated into the health system (Klobodu *et al.*, 2023), and wanted fertility clinics to improve access to nutrition professionals (Latifi *et al.*, 2022). Women felt that lifestyle was not discussed early enough in treatment (Ockhuijsen *et al.*, 2012; Riggan *et al.*, 2023), particularly where their BMI affected treatment eligibility (Riggan *et al.*, 2023). For those who did receive lifestyle advice, recommendations were seen as irrelevant, impractical, and lacking in detail (Porter and Bhattacharya, 2008; Ockhuijsen *et al.*, 2012; Klobodu *et al.*, 2023). Consequently, patients often sought information from alternative avenues, such as the internet and print media, which they considered to be helpful (Porter and Bhattacharya, 2008).

Mode of delivery

People with infertility expressed that feelings of anxiety triggered by attending fertility clinics (Uraz *et al.*, 2019) and logistical challenges (Uraz *et al.*, 2019; Boedt *et al.*, 2021) are barriers to engaging in clinic-led lifestyle programmes. Both people with infertility and health professionals felt the use of digital health would support adoption of healthy lifestyles (Van Dijk *et al.*, 2017; Sacha *et al.*, 2018; Uraz *et al.*, 2019). While men considered face-to-face lifestyle consultations to be fully replaceable by a mobile-health, women preferred a hybrid model of a combination of face-to-face consultations and mobile-health (Van Dijk *et al.*, 2017). Both women with infertility and nurses emphasized the value of an online patient-facing for the self-administered lifestyle risk screening tool. This would enable nurses to efficiently address risk factors in a personalized way (Ockhuijsen *et al.*, 2012), and streamline low-risk patients risk to less intensive telehealth consultations (Ockhuijsen *et al.*, 2012). Educational handouts for patients (both physical leaflets and multimedia) and manuals/guides for health professionals were also viewed as enablers to adoption and delivery of lifestyle recommendations (Ockhuijsen *et al.*, 2012; Jayasena *et al.*, 2020). People with infertility also appreciated when lifestyle advice provided practical strategies for scalable changes delivered over time, ideally involving six sessions (Ockhuijsen *et al.*, 2012; Van Dijk *et al.*, 2017; Uraz *et al.*, 2019).

Support from partner, peers, and health professionals

While people with infertility were apprehensive about lifestyle interventions delivered in large groups (Oron *et al.*, 2015; Uraz *et al.*, 2019) and disliked it when group members raised questions irrelevant to their own needs (Uraz *et al.*, 2019), they felt more comfortable with group dynamics over time (Uraz *et al.*, 2019). Women also acknowledged benefits of peer support, with group interventions facilitating feedback, accountability, and a sense of connection (Simon *et al.*, 2013; Oron *et al.*, 2015; Uraz *et al.*, 2019). Patients also considered support from their partner (Simon *et al.*, 2013; Uraz *et al.*, 2019) and health professionals to be an important enabler to lifestyle change (Simon *et al.*, 2013; Uraz *et al.*, 2019; Boedt *et al.*, 2021; Riggan *et al.*, 2023), particularly when an empathetic approach to care was provided by health professionals (Ockhuijsen *et al.*, 2012; Riggan *et al.*, 2023).

Catering for others

Women with infertility considered picky eaters in the household and social obligations (e.g. entertaining) to be a barrier to healthy eating at least some of the time (Simon *et al.*, 2013).

Themes relating to motivation

Understanding the importance and consequences of lifestyle change

For people with infertility, misconceptions about impacts of lifestyle change on fertility stemmed from cultural and societal influences. These included adapting their diet to align with cultural practices (e.g. Chinese medicine principle of hot and cold body energies) (Read *et al.*, 2014), beliefs that exercise was unnecessary or harmful while trying to conceive (Porter and Bhattacharya, 2008; Gundimi *et al.*, 2022), and concerns that delaying fertility treatment for preconception weight loss would narrow the reproductive window (Riggan *et al.*, 2023). For health professional (nurses, nutritionists, and infertility specialists), weight management was more likely to be considered important when compared to diet and exercise (Homan *et al.*, 2018; Langarizadeh *et al.*, 2022). Overall, people with infertility considered preconception lifestyle change important in influencing fertility outcomes (Homan and Norman, 2009; Vause *et al.*, 2009; Simon *et al.*, 2013) and recognized benefits for overall health that extended beyond fertility (Homan and Norman, 2009; Gundimi *et al.*, 2022).

Belief that patients do not want health professional-led lifestyle education

Health professionals (gynaecologists and fertility doctors) were concerned that patients are not interested in health professional-led lifestyle education (Van Dijk *et al.*, 2017). Similarly, nurses cited previous poor uptake of lifestyle modification programmes as a reason why their clinics did not offer these programmes (Homan *et al.*, 2018). In addition, nurses were concerned about appearing accusatory when discussing topics such as weight management (Ockhuijsen *et al.*, 2012).

Confidence in skills required to follow a healthy lifestyle

Women with infertility reported varying levels of confidence in the skills required to follow a healthy lifestyle, with low levels of confidence in their cooking skills emphasized as a key barrier (Simon *et al.*, 2013). However, following a dietitian-led group intervention enhanced their confidence in their ability to prepare healthy meals and make healthy shopping choices (Simon *et al.*, 2013). Similarly, women who participated in a nurse-led lifestyle intervention described having improved self-efficacy to manage their infertility (Li *et al.*, 2017). Women also voiced that health professional supervision would help them to lose more weight in a shorter amount of time (Sacha *et al.*, 2018), and to meet BMI eligibly criteria for fertility treatment (Riggan *et al.*, 2023).

Considering the stage of change

For some individuals with infertility, competing priorities such as their career presented barriers to viewing lifestyle change as a priority (Homan and Norman, 2009). In addition, the stage of change (as defined by the transtheoretical model (Prochaska and Velicer, 1997)) varied for different lifestyle components: women with obesity and infertility had a higher level of readiness to change for weight loss compared to physical activity (Karsten *et al.*, 2019).

Professional responsibility

Some health professionals employed in fertility clinics believed lifestyle management was not the clinic's responsibility, and instead placed the responsibility on patients or other external health professionals (Boedt *et al.*, 2023). However, the vast majority of fertility clinic staff considered that the clinic doctors and nurses have a responsibility to promote healthy lifestyle for

patients seeking ART (Homan et al., 2018; Boedt et al., 2023), with nurses being more likely than gynaecologists to adopt this perspective (Boedt et al., 2023). Reasons for fertility clinic staff viewing healthy lifestyle promotion as part of their professional role included its effect on treatment outcomes (including fertility, pregnancy complication reduction, and offspring health), reducing health care costs for society, and providing patients with education and empowerment (Boedt et al., 2023). Although nurses recognized the crucial role of their clinics in healthy lifestyle information provision, they emphasized the value of coordinating multi-disciplinary care, by providing referrals to allied health providers that could offer more tailored and structured programmes (Homan et al., 2018; Boedt et al., 2023).

Interplay between lifestyle and emotional state

Emotional eating was a barrier to a healthy lifestyle in women with infertility (Porter and Bhattacharya, 2008; Simon et al., 2013; Karsten et al., 2019). Distress experienced during the infertility journey was compounded by feelings of self-blame following unsuccessful attempts to reduce weight and make lifestyle changes (Porter and Bhattacharya, 2008). Some people also experienced a lack of enjoyment from exercise (Homan and Norman, 2009). In contrast, people who made positive lifestyle changes during their infertility journey described a feeling of empowerment, by proactively taking actions to improve their chances of successful conception (Porter and Bhattacharya, 2008; Oron et al., 2015). Although some people only viewed their lifestyle changes positively after conception (Porter and Bhattacharya, 2008), others described how lifestyle changes such as yoga assisted with stress management (Oron et al., 2015; Dreischor et al., 2022). Additionally, women who participated in lifestyle interventions that incorporated mental health strategies reported that this helped them to feel more at peace with the future regardless of the pregnancy outcome (Oron et al., 2015). Low intensity forms of exercise, including yoga and walking, were viewed more favourably by women with infertility (Gundimi et al., 2022).

Providing lifestyle intervention is rewarding

An enabler to health professional provision of lifestyle intervention was that nurses enjoyed motivating and supporting patients with reaching their goals (Ockhuijsen et al., 2012).

Intervention functions, policy categories, BCTs, and components

Suggested components to include in lifestyle interventions for people with infertility are displayed in Supplementary Tables S10 and S11, with selected examples illustrated in Fig. 2. Overall, suggested intervention components emphasize the importance of shared decision-making, empowering patients with practical strategies, tailoring lifestyle education to individuals' needs, and incorporating mental health strategies. Suggested intervention functions and policy categories (to deliver and enable implementation of the intervention functions) are displayed in Table 3. There were 34 BCTs identified across the suggested intervention functions, encompassing 14 of the 16 BCT categories (Table 4).

Discussion

In this mixed-methods systematic review, we reported that barriers and enablers to achieving a healthy lifestyle from the perspectives of people with infertility included emotional eating and time constraints versus social support and awareness of lifestyle risk factors respectively. Provision of lifestyle advice by health professionals was influenced by barriers including time constraints and enablers including use of online resources to support intervention delivery.

Themes relating to capability demonstrated the crucial role of perception of the role of lifestyle and self-management strategies in influencing behaviours of people with infertility and health professionals. Consistent with previous literature in preconception women (Kandel et al., 2021), knowledge was both an enabler and barrier depending on patients' level of education relating to awareness of lifestyle risk factors (BMI, diet, and physical activity) on fertility. However, no studies specifically assessed the awareness of people with infertility regarding the impacts of underweight or excessive physical activity on fertility. Nevertheless, improving risk perception by addressing knowledge gaps on the relationship between lifestyle and fertility is essential to improve engagement with lifestyle interventions (Ferrer and Klein, 2015). It is additionally crucial for interventions to extend beyond information provision, and intervention components identified here encourage the use of goal setting, action planning, and problem solving. Self-management strategies are essential to facilitate the capability to engage in meaningful behaviour change, supported by self-monitoring of diet, physical activity, and/or weight via digital health, being associated with improved diet and physical activity or weight loss in adults with overweight or obesity (Teasdale et al., 2018; Patel et al., 2021; Laranjo et al., 2021). Of note, any focus on weight loss should be considered in light of the higher prevalence of disordered eating and eating disorders among people with infertility compared to the general population (Hecht et al., 2022) given concerns that self-monitoring of dietary intake in the general population could contribute to guilt and disordered eating in susceptible individuals (Orji et al., 2018). We acknowledge the need for an individualized approach to ensure that care provision is both safe and effective and highlight the identification of shared decision-making between the health professional and patient in our intervention components to ensure a tailored and appropriate approach.

Themes relating to opportunity highlighted limited availability of time and resources as major barriers from the perspectives of both people with infertility and health professionals. To overcome this, both groups emphasized the value of digital health in supporting efficient and targeted care. Dietary interventions delivered via telehealth are effective at improving diet quality and clinical outcomes in adults with chronic conditions (Kelly et al., 2016), and could address logistical challenges and anxiety induced by attending fertility clinics for lifestyle intervention. Of note, opportunity for lifestyle management of infertility can evolve over time; while advancements in telehealth enhanced enablers, COVID-19 pandemic-related disruptions in the food supply exacerbated barriers (Claydon et al., 2022). Themes relating to opportunity also highlighted the complex interpersonal dynamics experienced by people with infertility. Women with infertility cited partner support as an important enabler to a healthy lifestyle. Although conception is an event that requires contribution from both male and female partners in heterosexual couples, women with infertility disproportionately bear the burdens of fertility treatment (Inhorn and Patrizio, 2015). We identified less data on perspectives of men compared to those of women, which may be caused by men's reluctance to discuss infertility with researchers (Lloyd, 1996), as well as the overall tendency for infertility research to focus on women (Culley et al., 2013). However, men view themselves as an important source of support for their partners during the infertility journey, even in cases of male-factor infertility (Bell, 2016). Hence, our suggested interventions recommend collaboration between partners in

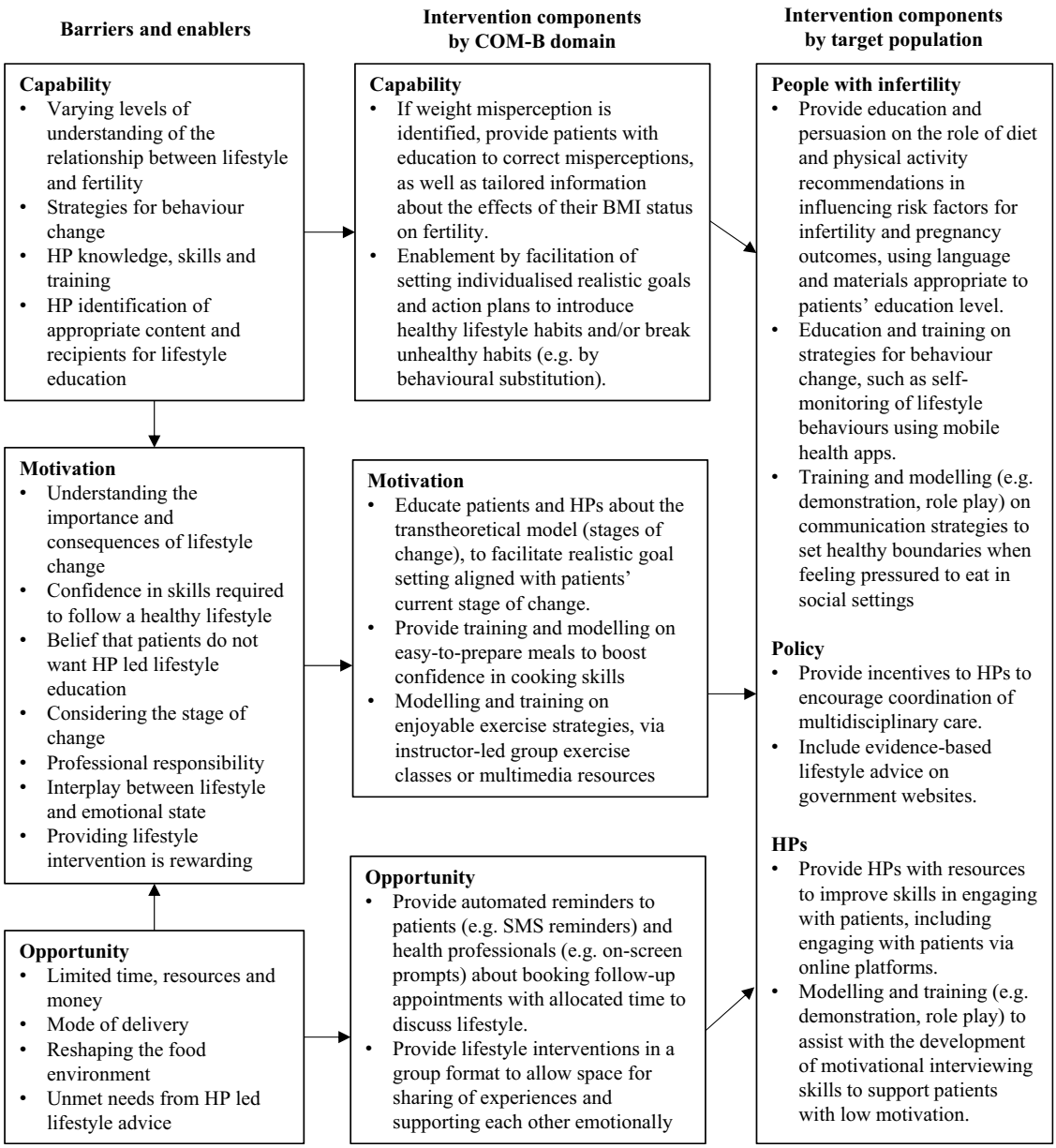

Figure 2. Suggested intervention components to include in lifestyle interventions for infertility. COM-B, Capability, Opportunity, Motivation and Behaviour; HP, health professional; SMS, short message service.

lifestyle modification. Additionally, we highlighted the potential benefits of lifestyle interventions delivered in a group setting, with participants expressing appreciation for the opportunity to connect with people in similar situations. This sense of connection is particularly valuable during the infertility journey, which is often accompanied by feelings of loneliness and isolation (Hinton *et al.*, 2010; O'Connell *et al.*, 2021). We recommend limiting participant numbers and ensuring intervention personnel are trained to manage group interactions and ensure congruity of goals for all patients to overcome the reluctance of patients to engage with group interventions relating to factors including discomfort with group dynamics (Oron *et al.*, 2015) or programme content not being relevant to their personal goals (Uraz *et al.*, 2019).

Themes relating to motivation highlighted varying opinions on the importance of different lifestyle factors and the complex interplay between lifestyle and emotions experienced during the infertility journey. Health professionals often considered weight management more important than lifestyle behaviours such as diet and exercise and were more likely to discuss weight in consultations. This prioritization may be reflective of the presence of BMI cut-offs in many countries, affecting eligibility for publicly funded fertility treatment, which has been criticized due to insufficient evidence to support their benefit (Legro, 2016). When lifestyle discussions focus on weight rather than diet and physical activity, this may be viewed as stigmatizing and lacking in practical strategies for change (Koball *et al.*, 2018). Furthermore, it is essential to consider the complex and intertwined relationship between stress experienced during the infertility journey and difficulty managing weight. Women with infertility who experienced unsuccessful weight loss attempts described feelings of shame and blamed themselves for their inability to fall pregnant, exacerbating emotional eating (Porter and Bhattacharya, 2008; Wong and Qian, 2016). Referral for evidence-based psychological interventions such as cognitive behavioural therapy may be indicated in these situations (Smith *et al.*, 2023). Additionally, to

Table 3. Intervention functions and policy categories corresponding to the suggested interventions to address barriers and enablers within each theme.

		Intervention Functions						Policy Categories					
	Themes	**Education**	**Persuasion**	**Incentivization**	**Training**	**Environmental restructuring**	**Modelling**	**Enablement**	**Communication/marketing**	**Guidelines**	**Fiscal**	**Environmental/social planning**	**Service provision**
People with infertility	Varying levels of understanding of the relationship between lifestyle and fertility	✓	✓						✓				✓
	Strategies for behaviour change	✓			✓			✓					✓
	Reshaping the food environment				✓	✓	✓	✓				✓	✓
	Limited time, resources, and money				✓	✓	✓		✓			✓	✓
	Mode of delivery					✓		✓	✓			✓	✓
	Unmet needs from health professional-led lifestyle advice	✓			✓	✓		✓	✓	✓			✓
	Support from partner, peers, and health professionals					✓		✓				✓	✓
	Catering for others	✓			✓	✓	✓	✓	✓			✓	✓
	Understanding the importance and consequences of lifestyle change	✓	✓		✓				✓				✓
	Confidence in skills required to follow a healthy lifestyle	✓	✓		✓		✓		✓				✓
	Considering the stage of change	✓	✓						✓				✓
	Interplay between lifestyle and emotional state	✓	✓				✓	✓	✓				✓
Health professionals	Identification of appropriate content and recipients for lifestyle education	✓			✓			✓	✓	✓			✓
	Health professionals' knowledge, skills, and training				✓								✓
	Limited time, resources, and money				✓	✓		✓				✓	✓
	Mode of delivery					✓				✓		✓	
	Belief that patients do not want health professional-led lifestyle education	✓			✓		✓		✓				✓
	Understanding the importance and consequences of lifestyle change	✓	✓						✓				✓
	Professional responsibility	✓	✓	✓					✓	✓	✓		✓
	Providing lifestyle intervention is rewarding		✓						✓				

Table 4. Categories of behaviour change techniques suggested to address barriers and enablers within each theme.

	Themes	1. Goals and planning	2. Feedback and monitoring	3. Social support	4. Shaping knowledge	5. Natural consequences	6. Comparison of behaviour	7. Associations	8. Repetition and substitution	9. Comparison of outcomes	10. Reward and threat	11. Regulation	12. Antecedents	13. Identity	15. Self-belief
People with infertility	Varying levels of understanding of the relationship between lifestyle and fertility		✓			✓				✓					
	Strategies for behaviour change	✓	✓						✓						
	Reshaping the food environment	✓	✓		✓		✓		✓				✓		
	Limited time, resources, and money	✓			✓		✓		✓				✓		
	Mode of delivery	✓	✓		✓	✓		✓					✓		
	Unmet needs from health professional-led lifestyle advice	✓			✓	✓				✓					
	Support from partner, peers, and health professionals	✓		✓						✓			✓		
	Catering for others	✓			✓	✓	✓		✓				✓	✓	
	Understanding the importance and consequences of lifestyle change				✓	✓				✓					
	Confidence in skills required to follow a healthy lifestyle			✓	✓		✓								✓
Health professionals	Considering the stage of change	✓			✓	✓				✓				✓	
	Interplay between lifestyle and emotional state	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	
	Identification of appropriate content and recipients for lifestyle education	✓			✓	✓	✓		✓						
	Health professionals' knowledge, skills, and training				✓	✓	✓		✓						
	Limited time, resources, and money	✓			✓								✓		
	Mode of delivery				✓								✓		
	Belief that patients do not want health professional led lifestyle education				✓		✓		✓						
	Understanding the importance and consequences of lifestyle change					✓				✓					
	Professional responsibility				✓					✓	✓				✓
	Providing lifestyle intervention is rewarding					✓	✓								

break the cycle of shame related to weight, providers of lifestyle interventions could consider shifting the focus away from weight by informing people with infertility of the benefits of healthy lifestyle behaviours independent of weight (Salvia *et al.*, 2023), and encouraging consumers to reframe healthy lifestyle behaviours as broader self-care strategies.

Strengths and limitations

This review has several strengths. We used a comprehensive search strategy, and the use of the convergent integrated approach allowed for data triangulation. Credibility of findings was increased by including perspectives of two important groups of stakeholders, people with infertility and health professionals. The use of established frameworks including the COM-B and TDF additionally supports structured development of interventions to target identified enablers and barriers. We acknowledge limitations of this review. Conducting a mixed-methods systematic review required us to synthesize highly heterogeneous data. While we used published guidelines to inform our methodology and ensure appropriate integration and analysis of data, the disproportionately large number of quantitative studies may limit interpretation of findings. Most of the surveys included in this study were not validated and used close-ended questions that could not cover all possible answers. This may have led participants to answer inauthentically or misinterpret questions. Surveys also cannot capture rich perspectives gained through qualitative inquiry. For example, while our findings indicated people with infertility understood the relationship of elevated BMI and physical inactivity with infertility, this was informed by survey data that did not inquire about their awareness of the detrimental effects of having a low BMI or excessive physical activity. Similarly, while our findings indicated women identified having picky eaters in the household, social obligations and their lack of skills to cook healthy meals as obstacles to adopting healthy behaviours, rating a list of predefined barriers does not provide adequate context to understand how or why these obstacles impact their behaviours. Hence, this review has importantly highlighted the incomplete nature of the literature, indicating a need for more qualitative research. Additionally, none of the qualitative studies included in our review adequately addressed the researcher–participant relationship, which may contribute to bias in the results. Furthermore, there were a limited number of studies reporting on the perspectives on health professionals, particularly allied health professionals, with no studies reporting on perspectives of physiotherapists or exercise physiologists. Finally, the majority of research was published in higher income countries. This limited the generalizability of our findings and our ability to evaluate geographical or temporal trends in enablers and barriers.

Implications for practice and research

Our systematic review identified several interacting factors, which influence lifestyle behaviours in people with infertility. We suggest intervention components that may be considered by stakeholders involved in intervention development and delivery when optimizing lifestyle interventions for people with infertility. We identified gaps in existing literature, highlighting the need for further qualitative research to enhance understanding of barriers and enablers to lifestyle change from the perspectives of both people seeking fertility services and health professionals across diverse professions, cultural backgrounds, education levels, sexual orientations, and socioeconomic positions. Hence, it is likely that there are additional enablers and barriers to lifestyle change, which were not captured in this review. Additionally, there is a need for research to synthesize barriers and enablers to other lifestyle modifications such as cessation of alcohol and tobacco use, which were not within the scope of this review. As additional evidence on the perspectives of people with infertility and health professionals becomes available, the suggested interventions can be further refined to suit the needs of the specific populations and settings to which they are applied.

Conclusion

Several interacting factors influence lifestyle in people with infertility, including knowledge, use of behavioural change strategies, time and resource availability, interpersonal interactions, self-efficacy, and emotions experienced during the infertility journey. Health professionals similarly experience several factors influencing delivery of lifestyle interventions, including knowledge, time and resource availability, and varying perspectives about the role of lifestyle intervention and their own professional role in delivering lifestyle interventions. By considering the unique perspectives of people with infertility and health professionals involved in their care, lifestyle interventions can be designed and developed according to these perspectives. As such, we recommend that the information provision component of interventions gives focus to lifestyle changes beyond weight loss, and includes information on beneficial effects of lifestyle changes beyond improvements in fertility. We recommend that interventions extend beyond information provision, by enhancing capability via support for practical strategies for behaviour change, enhancing opportunity via involvement of the partner, and enhancing motivation by encouraging the reframing of lifestyle changes as self-care strategies. Therefore, the evidence synthesized in our review can help support the development of successful lifestyle interventions for infertility.

Supplementary data

Supplementary data are available at *Human Reproduction Update* online.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

Authors' roles

S.T., L.Z., K.L., D.B., W.X., L.M., and S.C. contributed to eligibility assessment. S.T. and K.L. contributed to data extraction. S.T., L.M., and S.C. contributed to data analysis. S.T., L.Z., K.L., W.X., and L.M. contributed to quality assessment. S.T. wrote the first draft of the manuscript. R.W., R.J.N., L.M., and S.C. provided supervision to the review process. L.M. and S.C. contributed as senior authors. All authors provided intellectual input. All authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship and approved the final version for publication.

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Conflict of interest

The authors have no conflicts of interest.

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