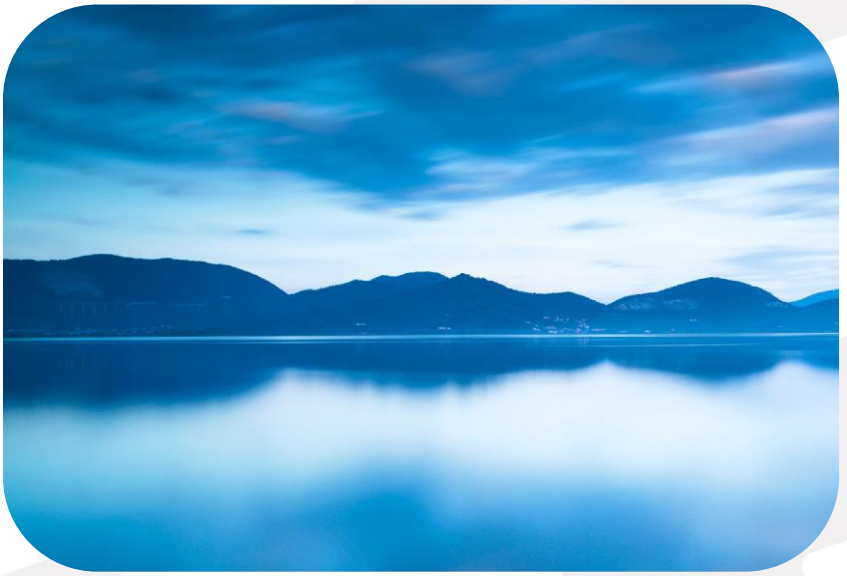
Assisted reproductive technologies:

International approaches to public funding mechanisms and criteria.
An evidence review



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Abbreviations

ART	assisted reproductive technology
CCG	clinical commissioning group
ESHRE	European Society of Human Reproduction and Embryology
ICSI	intracytoplasmic sperm injection
IUI	intrauterine insemination
IVF	in vitro fertilization
MAR	medically assisted reproduction
NICE	National Institute for Health and Care Excellence
PGD	preimplantation genetic diagnosis
WHO	World Health Organization

Executive summary

Purpose and questions

In the context of enacting comprehensive regulation for assisted human reproduction in Ireland, the Department of Health is considering, in addition to legislation, whether to provide public funding for assisted reproductive technology and what form this funding, if approved, might take. As part of these considerations, the Department asked the HRB Evidence Centre to review the literature to answer four specific questions:

1. Describe the public funding mechanisms for assisted reproductive technologies operated in a number of jurisdictions.

2. What are the costs and benefits associated with the public funding of assisted reproductive technologies for the funder, provider and service user?

3. What are the criteria for accessing publicly funded assisted reproductive technology services in a number of jurisdictions?

4. What are the countries' justifications for their criteria for accessing publicly funded assisted reproductive technology services and are these justifications supported by clinical evidence?

Methods

The methods used to undertake this work followed the principles and practice of a systematic review, including searching, screening, applying inclusion/exclusion criteria, data extraction, quality appraisal and synthesis, and these are presented in the methods section. A detailed account of each step is provided and a robust critique of our work is documented in the discussion and conclusion section.

Findings

Question 1: Funding mechanisms

There are three public funding mechanisms for assisted reproductive technology treatment reported in the papers we reviewed: full funding, defined as 81% or more for at least one cycle; partial funding, defined as between 1 and 80% for at least one cycle; and no funding provided from the public health system. Within Europe, six countries offer full public funding, and outside Europe, Israel, New Zealand, and Ontario (Canada) offer full funding. Within Europe, 19 countries offer partial public funding, and outside Europe, Australia provides partial funding. The countries that provide partial public funding require substantial out-of-pocket payments from patients per cycle. Eight of the countries reviewed do not fund assisted reproductive technologies; however, some of the eight countries with no public funding have other mechanisms to help pay for treatment (such as tax credit or means

tested subsidy). Since 2008 the number of countries providing public funding for assisted reproductive technologies has increased, but individual countries' level of public funding has decreased and out-of-pocket payments have increased. The most common services provided through publicly funded assisted reproductive technologies are intrauterine insemination, in vitro fertilization or intracytoplasmic sperm injection, and preimplantation genetic diagnosis. The number of cycles funded through public health services varies, from one cycle in Ukraine to a limitless number of cycles in Australia, Czech Republic, Estonia and Israel.

Question 2: Costs and benefits

One main benefit associated with public funding for infertility treatment include improving access to treatment by reducing out-of-pocket payments; this benefit may encourage patients with fertility problems from lower socioeconomic groups to avail of the service, as currently women in higher socioeconomic groups are proportionally more likely to use the service. There are also clinical benefits to be accrued, which can in tandem reduce the pressure on public spending. In some countries, public funding is contingent on patients and clinicians agreeing to restrict the number of embryos transferred in one cycle. Where this has occurred, there has been a significant reduction in multiple pregnancies without causing a decrease in cumulative pregnancy rates, as well as millions in estimated savings to the public health system. There are also inferred benefits to wider society when public funding for fertility treatment is approved. Public funding for fertility treatment is seen in some countries as a social investment towards arresting the declining fertility rate and boosting the growth of future populations and overall revenue receipts. The papers reviewed suggest that the overall economic cost to society is relatively modest in the context of public spending from the overall health budget.

For women aged over 40 years, live births are substantially less likely following assisted reproductive technology treatments and the financial cost of achieving a live birth is substantially more. Greater access can be achieved by improving the affordability of assisted reproductive technologies to the patient. However, a balance must be struck in crafting any state support so as to incentivize patients and service providers to engage in clinical practices that will not have devastating health or financial outcomes for patients or potential offspring, or subsequent long-term financial ramifications for society. Every country has a different approach to this and the likely funding mechanism may emerge through trial and error. In Alberta, Canada, researchers modelled a variety of funding approaches to different age subgroups of women, from fertility need to the 18th birthday of the potential baby born. This demonstrated that state funding with regulation can provide a cost-effective solution for patients who are subfertile and for wider society, and may prove to be a guide to policy-makers seeking a funding model.

Questions 3 and 4: Access criteria for public funding and rationale

From the papers we reviewed, it appears that all countries which provide either partial or full public funding towards assisted reproductive technologies set criteria for receiving this funding. These criteria can be grouped into two broad categories: clinical and social. Clinical criteria include a female upper age limit, the need for a medical indication, restrictions on the number of embryos transferred, and the body mass index and current smoking and/or

substance use status of applicants. Social criteria include civil or marital status, previous children and child protection. The female upper age limit and medical indication are the most commonly employed criteria for receiving publicly funded assisted reproductive technologies, although a number of countries examining the evidence base for increasing the success of assisted reproductive technologies have included body mass index, current smoking status and promoting the use of single-embryo transfer for women in their early to mid-thirties.

Clinical and social criteria are justified on the grounds of safety, successful outcomes and cost-effectiveness, although social and political concerns with demography, changing social trends and behaviours, and political pressure are equally prominent considerations in the papers reviewed. It would appear that scientific evidence, social concerns and to some extent financial considerations form the main planks of justification when policy-makers adjudicate on decisions about funding assisted reproductive technologies and setting access criteria. We conclude that national policies are a hybrid of political, cultural and economic pressure combined with clinical evidence leading to a publicly acceptable or pragmatic approach to funding assisted reproductive technologies in each individual country examined.

1 Introduction

Assisted reproductive technology (ART) is the application of laboratory or clinical technology to gametes (human eggs or sperm) and/or embryos for the purposes of reproduction.

Currently, assisted reproductive technologies are unregulated in Ireland. In February 2015, the Minister for Health received Government approval to draft the General Scheme of a Bill for Assisted Human Reproduction, which will include provisions on assisted human reproduction and associated research. This will regulate a range of practices for the first time, including surrogacy, embryo donation, preimplantation genetic diagnosis of embryos, gamete (sperm or egg) donation and stem cell research. The legislation will also establish a specific regulatory authority for assisted human reproduction. The proposed legislation has a number of objectives, most importantly protecting and promoting the health and safety of children born through assisted human reproduction, their parents, and others who may be involved in the process such as donors and surrogate mothers.

Currently, assisted reproductive technologies, including in vitro fertilization, are not provided for by the Irish public health system, but fertility drugs may be partially funded through a public funding scheme. The cost of a single in vitro fertilization cycle in a private Irish fertility clinic ranges from €4,100 to €5,900, whereas intracytoplasmic sperm injection costs between €5,200 and €6,400. Patients who access fertility treatments may claim tax relief on the costs involved under the tax relief for medical expenses scheme. In addition, a defined list of medicines required for fertility treatment is covered under the High Tech Scheme administered and funded by the Health Service Executive. Medicines covered by the High Tech Scheme must be prescribed by a consultant/specialist and approved by the Health Service Executive's designated staff. The cost of the medicines is then covered, as appropriate, by the Medical Card or High Tech Scheme. GloHealth, Laya Healthcare and VHI Healthcare are the only three insurers in Ireland that offer some coverage for assisted reproductive services.

Public financing of assisted reproductive services is not integral to the legislative process. Nonetheless, in the context of comprehensive regulation of assisted human reproduction, consideration needs to be given as to whether there will be public funding in the form of full coverage or partial coverage and what the attached conditions will be, such as medical indication, single-embryo transfer, number of cycles, and up to what age.

The purpose of the requested evidence review is to describe international public funding mechanisms for assisted reproductive technologies in order to inform the Department of Health's considerations regarding the most appropriate public funding mechanisms for assisted reproductive technologies within the Irish context.

2 Research questions

The purpose of the requested evidence review is to describe international public funding mechanisms for assisted reproductive technologies in order to inform the Department of Health's considerations regarding the most appropriate public funding mechanisms for assisted reproductive technologies within the Irish context.

The specific research questions are:

Question 1: Describe the public funding mechanisms for assisted reproductive technology operated in a number of jurisdictions.

The Department of Health asked that the response to this question describe the public funding mechanism, including the type of funding mechanism, the source of national healthcare funding, who can access public funding, what is covered by public funding, whether there is public funding provided through private operators and how this operates, and the role of third-party funders (private health insurance companies).

Question 2: What are the costs and benefits associated with the public funding of assisted reproductive technology for the funder, provider and service user?

The Department of Health asked that this question be answered under the following headings: type of funding mechanism by economic equity (affordability and accessibility); patient safety; reproductive outcomes; and costs to tax payer and benefits to society.

Question 3: What are the criteria for accessing publicly funded assisted reproductive technology services in a number of jurisdictions?

The Department of Health asked that this question consider the following criteria: age, gender, marital status, medical indication, co-morbidity, child protection, number of cycles, number of embryos, and any other criteria that emerge in the literature.

Question 4: What are the countries' justifications for their criteria for accessing publicly funded assisted reproductive technology services and are these justifications supported by clinical evidence?

3 Methods

3.1 Searching for relevant studies

We undertook a systematic search of the MEDLINE bibliographic database using a combination of controlled vocabulary terms (MESH) and free-text terms (Table 1). When we administered our exclusion and inclusion criteria (see Section 3.2 for a full description of these criteria) we identified 801 titles that could potentially provide data to answer our questions. We then imported these 801 titles into EPPI-Reviewer for screening. In addition, we undertook an additional search of international health agencies listed in the Grey Matters search tool. From this search, we identified 24 papers that could potentially provide useful data; however, none of these 24 papers had pertinent information. We supplemented these targeted searches with searches of Google and Google Scholar for published reports from the main surveillance agencies that compile and publish data on assisted reproductive technologies. We also undertook a number of hand searches of two established journals in the field: *Human Reproduction* and *Fertility and Sterility*. We also screened bibliographies from the retrieved papers for additional references.

Table 1 Literature search to address the research questions

Database	Search date	Search string	Results
MEDLINE Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R)	16/03/2016	1. exp Reproductive Techniques, Assisted/ 2. exp Health Care Rationing/ 3. exp Financing, Government/ 4. ((resource* adj1 allocation*) or (fund* adj1 mechanism*) or (public adj1 fund*)).ab,ti. 5. ((assisted adj1 reproduc) or ivf).ti,ab. 6. Eligibility Determination/ or eligib*.ti,ab. 7. exp Policy/ or polic*.ti,ab. 8. 2 or 3 or 4 or 6 or 7 9. 1 or 5 10. 8 and 9 11. limit 10 to English language 12. limit 11 to yr="2007 -Current"	801

3.2 Inclusion and exclusion criteria

From the outset of our systematic search, we excluded papers that were published before 2007. This decision was made on the grounds that our remit for the review was to produce

an up-to-date picture of public funding models for assisted reproductive technology treatment and we decided that data going back more than eight or nine years would yield little benefit. We also observed from screening a small sample of papers at the beginning of our review that there were sometimes gaps of four to six years between data being collected and reported. For example, the European Society of Human Reproduction and Embryology papers were illustrative of this trend. In addition, we excluded papers that primarily focused on the funding of assisted reproductive technology treatment in low- and middle-income countries. This decision was based on our reasoning that the political and economic contexts in these locations were unlikely to share many features with the political and economic contexts in developed countries, including Ireland. Therefore, we were unlikely to be able to transfer the learning from low- and middle-income countries to Ireland. We also excluded any papers that were not published in the English language, as we did not possess translation facilities. Lastly, we excluded opinion pieces that were not based on primary research, secondary data analysis or theoretical and conceptual discussion.

Our inclusion criteria were mainly driven by the review questions, and all papers that explicitly reported on public funding of assisted reproductive technology treatment were candidates for inclusion in the review; specifically, papers that described public funding in developed countries, reported costs and benefits of public funding, and identified the criteria and explained the rationale for the criteria that countries set to access funding for assisted productive technology treatment. We included primary studies, systematic reviews and narrative reviews; primary studies could include qualitative theoretical and conceptual papers and quantitative empirical data papers. The search included peer review papers published between January 2007 and February 2016.

3.3 Screening

At the outset of our systematic search, we identified 801 papers with potential for inclusion in the review and we imported all 801 titles and abstracts into EPPI-Reviewer (Figure 1). We then screened these titles and abstracts and identified 100 papers that could potentially provide useful data. We did a full-text screening of all 100 papers and excluded 27, as they were opinion pieces. From the remaining 73 papers, we identified 52 papers that contained explicit reference to the public funding of assisted reproductive technology treatment and we retained these for further analysis. The remaining 21 papers had either minimal or no explicit reference to public funding, so we excluded these.

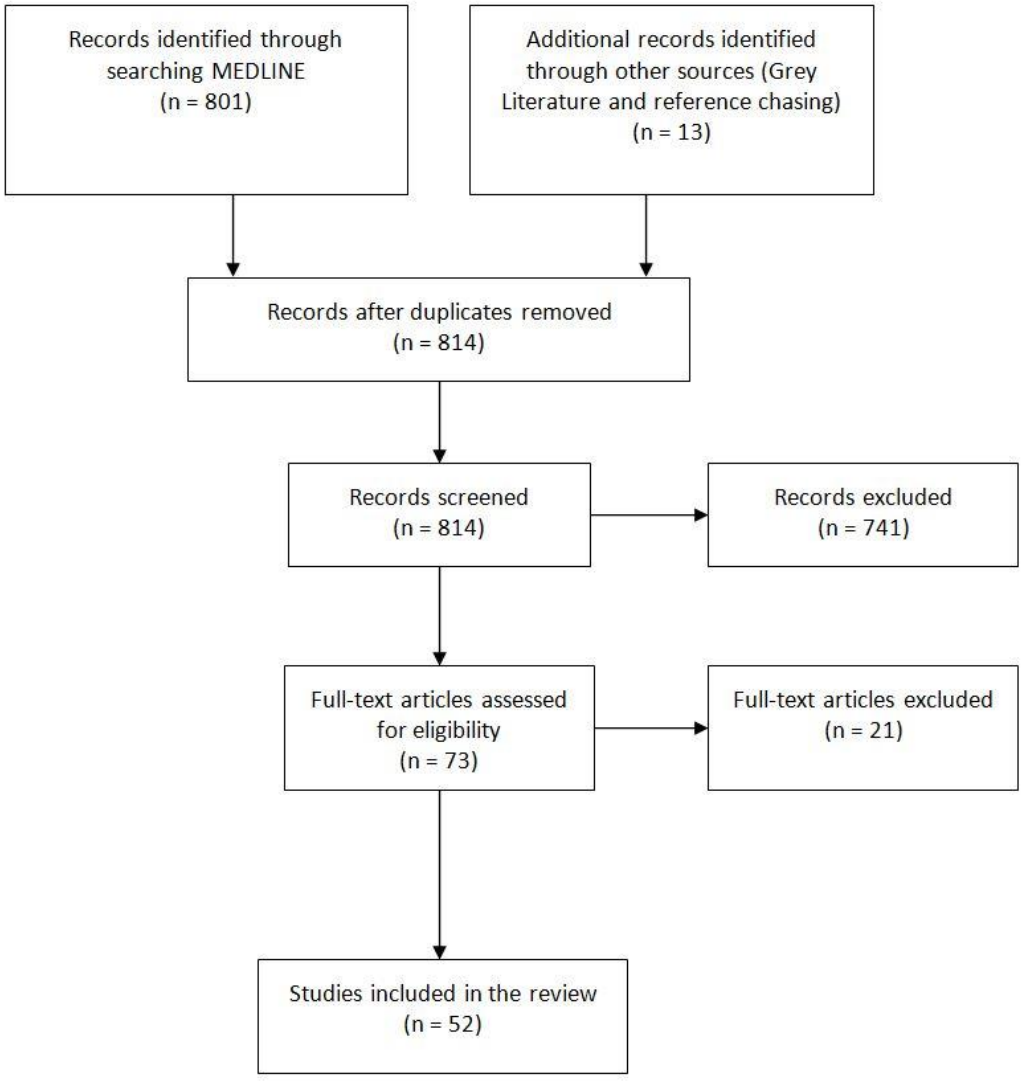

Figure 1 PRISMA flow chart for screening identified literature

3.4 Screening and grouping of included papers

In total, we undertook an in-depth full-text screening of 52 papers, which were located through systematic searching of relevant databases, and after screening were deemed relevant to provide data to address the four sub-questions in our review. These 52 papers comprised 13 reviews, including systematic reviews and narrative reviews, and 21 observational studies/policy evaluations, including evaluations of a policy intervention using a before-and-after design and retrospective secondary data analysis (Table 2). The remaining papers were 11 qualitative policy analysis papers and 7 papers that were primarily theoretical and conceptual in orientation.

Table 2 Grouping and number of papers included in assisted reproductive technologies review

Reviews	Observational studies/policy evaluations	Qualitative policy analysis	Papers not fit for appraisal but can make a contribution
13	21	11	7

We then screened the 52 papers to assess their contribution to answering the four review questions. We identified that most of the papers could potentially provide data to answer all four questions, although some papers appeared more useful for answering only specific questions. We then categorized the papers by question and allocated these to members of the team to begin further in-depth screening and data extraction. Table 3 provides a breakdown of the papers allocated per question. In total, we collected data from 47 of the 52 papers to answer the four review questions. In addition, we used data from a further 14 peer-reviewed papers and 7 grey literature documents which we retrieved through either citation chasing and/or search of three organisations' website (European Society of Human Reproduction and Embryology, International Federation of Fertility Societies and No Baby on Board). We collected and used data from a total of 68 papers to answer the 4 questions (see Appendix 1 for the characteristics of each paper).

Table 3 Four review questions and number of papers allocated to answer each question

Q1: Describe the public funding mechanisms for assisted reproductive technology operated in a number of jurisdictions?	Q2: What are the costs and benefits associated with the public funding of assisted reproductive technology for the funder, provider and service user?	Q3: What are the criteria for accessing publicly funded assisted reproductive technology services in a number of jurisdictions?	Q4: What are the countries' justifications for their criteria for accessing publicly funded assisted reproductive technology services and are these justifications supported by clinical evidence?
Balabanova and Simonstein (2010)[1]	Ata and Seli (2010)[2]	Balabanova and Simonstein (2010)[1]	Balabanova and Simonstein (2010)[1]
Berg Brigham *et al.* (2013)[3]	Berg Brigham *et al.* (2013)[3]	Berg Brigham *et al.* (2013)[3]	Berg Brigham *et al.* (2013)[3]
Birenbaum-Carmeli (2009)[4]	Bissonnette *et al.* (2011)[5]	Birenbaum-Carmeli (2009)[4]	Birenbaum-Carmeli (2009)[4]
Bretonnière (2013)[6]	Chambers *et al.* (2009)[7]	Bretonnière (2013)[6]	Bretonnière (2013)[6]
Chambers *et al.* (2009)[7]	Chambers *et al.* (2011)[8]	Chambers *et al.* (2009)[7]	Chambers *et al.* (2009)[7]
Chambers *et al.* (2011)[8]	Chambers *et al.* (2012)[9]	Connolly *et al.* (2009 a)[10]	Connolly *et al.* (2009a)[10]
Chambers *et al.* (2012)[9]	Chambers *et al.* (2013a)[11]	Connolly *et al.* (2011)[12]	Connolly *et al.* (2011)[12]
Chambers *et al.* (2013a)[11]	Chambers *et al.* (2013b)[13]	Cook *et al.* (2011)[14]	Cook *et al.* (2011)[14]
Connolly *et al.* (2009)	Chambers *et al.* (2013c)[15]	Dunn *et al.* (2014)[16]	Dunn *et al.* (2014)[16]
Connolly *et al.* (2011)[12]	Chambers *et al.* (2014a)[17]	Farquhar *et al.* (2010)[18]	Farquhar *et al.* (2010)[18]
Cook *et al.* (2011)[14]	Connolly *et al.* (2008)[19]	Gillett *et al.* (2012)[20]	Gillett *et al.* (2012)[20]
Dunn *et al.* (2014)[16]	Connolly *et al.* (2009a)[10]	Gooldin S. (2013)[21]	Gooldin (2013)[21]
Farquhar *et al.* (2010)[18]	Connolly *et al.* (2009b)[22]	Hodgetts *et al.* (2012)[23]	Hodgetts *et al.* (2012)[23]
Gooldin (2013)[21]	Connolly *et al.* (2010) (excluded)[24]	Hodgetts *et al.* (2014)[25]	Hodgetts *et al.* (2014)[25]
King *et al.* (2014) (excluded))[26]	Connolly *et al.* (2011)[12]	King *et al.* (2014) (excluded)[26]	King *et al.* (2014) (excluded)[26]
Klemetti *et al.*	Cook *et al.* (2011)[14]	Klemetti *et al.*	Klemetti *et al.*

Q1: Describe the public funding mechanisms for assisted reproductive technology operated in a number of jurisdictions?	Q2: What are the costs and benefits associated with the public funding of assisted reproductive technology for the funder, provider and service user?	Q3: What are the criteria for accessing publicly funded assisted reproductive technology services in a number of jurisdictions?	Q4: What are the countries' justifications for their criteria for accessing publicly funded assisted reproductive technology services and are these justifications supported by clinical evidence?
(2007)[27]		(2007)[27]	(2007)[27]
Maeda *et al.* (2014)[28]	Dunn *et al.* (2014[16])	Lindstrom and Waldau (2008) (excluded)[29]	Lindstrom and Waldau (2008) (excluded)[29]
Menon *et al.* (2015) [30]	ESHRE Capri Workshop Group (2010) (excluded)[31]	Maeda *et al.* (2014)[28]	Maeda *et al.* (2014)[28]
Mladovsky and Sorenson (2010)[32]	Kocourkova *et al.* (2014)[33]	Menon *et al.* (2015)[30]	Menon *et al.* (2015)[30]
Peeraer *et al.* (2014)[34]	Maeda *et al.* (2014)[28]	Mladovsky and Sorenson (2010)[32]	Mladovsky and Sorenson (2010)[32]
Silva and Barros (2012)[35]	Maheshwari *et al.* (2011) (excluded)[36]	Peeraer *et al.* (2014)[34]	Peeraer *et al.* (2014)[34]
Simonstein (2010)[37]	Menon *et al.* (2015)[30]	Silva and Barros (2012)[35]	Silva and Barros (2012)[35]
Simonstein *et al.* (2014)[38]	Nardelli *et al.* (2014) (excluded)[39]	Simonstein (2010)[37]	Simonstein (2010) [37]
Sol Olafsdottir *et al.* (2009)[40]	Navarro *et al.* (2008) (excluded)[41]	Simonstein *et al.* (2014)[38]	Simonstein *et al.* (2014)[38]
Street *et al.* (2011)[42]	Peeraer *et al.* (2014))[34]	Sol Olafsdottir *et al.* (2009)[40]	Sol Olafsdottir *et al.* (2009)[40]
Watt *et al.* (2011)[43]	Shaulov *et al.* (2015)[44]	Street *et al.* (2011)[42]	Street *et al.* (2011)[42]
	Simonstein *et al.* (2014)[38]	Watt *et al.* (2011)[43]	Watt *et al.* (2011)[43]
	Svensson *et al.* (2008)[45]		
	Umstad *et al.* (2013) (excluded)[46]		
	Velez *et al.* (2013) (excluded)[47]		
	Velez *et al.* (2014)[48]		
	Watt *et al.* (2011) [43]		

Q1: Describe the public funding mechanisms for assisted reproductive technology operated in a number of jurisdictions?	Q2: What are the costs and benefits associated with the public funding of assisted reproductive technology for the funder, provider and service user?	Q3: What are the criteria for accessing publicly funded assisted reproductive technology services in a number of jurisdictions?	Q4: What are the countries' justifications for their criteria for accessing publicly funded assisted reproductive technology services and are these justifications supported by clinical evidence?
Total number of papers = 26	**Total number of papers = 32**	**Total number of papers = 27**	**Total number of papers = 27**

3.5 Data extraction

3.5.1 Question 1 and Question 3

The systematic search and screening of literature for Question 1 identified 26 peer-reviewed papers, of which 18 were used. The systematic search and screening for Question 3 identified 27 peer-reviewed papers, of which 15 were used. Four additional peer-reviewed papers were obtained from citation searching for Question 3. The data used to answer Question 1 and Question 3 were based on grey literature from international fertility societies (four studies), two working group reports and one protocol, as well as 37 published, peer-reviewed papers. The guidance used to assist data extraction was the questionnaire developed by the European Society of Human Reproduction and Embryology (ESHRE) in the 2009 report titled *Comparative Analysis of Medically Assisted Reproduction in the EU: Regulation and Technologies*[49] and the parameters provided in Questions 1 and 3 were devised by the Department of Health. Data were extracted into tables from all major fertility reports and peer-reviewed papers published since 2008.

The data are mainly descriptive, presenting reported facts, and were taken from the findings sections of international reports and some of the peer-reviewed papers. However, data were also obtained from both the findings and introductory sections of the research studies identified as well as from legislation, policy and guidelines for English-speaking countries.

3.5.2 Question 2

The data presented to answer Question 2 are based on published, peer-reviewed literature. Thirty-seven potentially relevant peer-reviewed papers were reviewed for this question; of these, 20 were considered relevant and included in the review. Six of these 20 were systematic reviews and 14 included an economic evaluation. We excluded papers that did not include a focus on public funding mechanisms. The 20 included papers varied in design. A further five peer-reviewed papers were obtained through searching citations.

The guidance used to assist data extraction was the identification of costs or benefits for patient, provider and policy-maker/funder by the public funding mechanisms identified in Question 1 and the public funding criteria identified in Question 3. The data extraction table is in Appendix 2.

3.5.3 Question 4

From the full-text screening of the 52 papers retrieved from the systematic search, 29 were identified as potential candidates to provide data to answer Question 4. When these 29 were read in-depth, 20 were included and 9 excluded. An additional eight papers were identified from citation chasing and included in the review. The 28 papers included to provide data to help answer Question 4 included systematic reviews, quantitative primary and secondary data analysis, theoretical papers, policy analyses and primary qualitative research. It is important to note that none of the 28 papers had directly asked the same question as posed in Question 4 of this review; therefore, we needed to read each paper carefully to identify potential fragments of data to help build an answer to Question 4. Our data extraction was guided by two main constructs: i) was there any explicitly reported logic that underpinned the selection of criteria for funding in developed countries, i.e. were criteria supported by clinical or economic evidence, or ii) in the absence of explicit reporting of the links between logic and evidence, could we infer some connection between the criteria reported and the clinical evidence?

As the majority of papers did not explicitly report a direct link between jurisdictions choosing specific criteria and the clinical evidence, most of our data extraction was guided by making inferences of potential links between logic and evidence. For example, some papers reported that a female upper age limit, medical indication and restrictions on embryo transfers were predominantly set as criteria in some countries. However, the same papers did not report on the logic for these countries selecting these criteria. This meant that we extracted data from the relevant papers on these criteria and where they were applied, and then we searched for other papers to provide evidence for these criteria; when we found evidence we were able to infer some connection between the criteria chosen and the underpinning logic. However, this was not always possible, as in the case of the welfare of children where there does not appear to be any documented evidence and thus an absence of explicit logic or clear rationale. Some papers, such as that by Watt *et al*.[43] provided what may be called substantive data to answer Question 4, whereas other papers, such as those by Farquhar *et al*.[18] merely provided what we call supportive data. We extracted relevant data from different sections in the papers including the introduction, findings, discussion and conclusion.

3.6 Quality appraisal

The peer-reviewed papers included were quality appraised using one of four instruments: the Health Evidence Quality Assessment Tool for systematic reviews (Appendix 3); an adjusted version of the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) for economic studies (Appendix 4); the Mixed Methods Appraisal Tool (MMAT) – Version 2011 for quantitative and qualitative studies (Appendix 5); and the Authority,

Accuracy, Coverage, Objectivity, Date, Significance (AACODS) checklist for appraising grey literature (Appendix 6).

3.6.1 Question 1 and Question 3

The systematic reviews (Appendix 3), the 'grey literature' research reports (Appendix 6), the qualitative and quantitative peer-reviewed journal studies (Appendix 5) and the economic studies (Appendix 4) used for Question 1 and 3 were classified as moderate or strong quality. Some of the data for these two questions were obtained from legislation, policy and guideline documents and descriptive reports collating experiences, and these could not be quality assessed as they were not research studies. The data are taken from documents published in English. We were able to check data from English-speaking countries with their original sources, but we were not able to do this for non-English-speaking countries. Generally, the data we present were consistent between sources, and where the data were not consistent, usually there was a documented change in regulation or funding policy.

3.6.2 Question 2

We only used peer-reviewed papers and one research surveillance report to answer Question 2. The peer-reviewed papers included were quality appraised using one of three instruments: the Health Evidence Quality Assessment Tool for systematic reviews (Appendix 3); an adjusted version of the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) for economic studies (Appendix 4; and the Authority, Accuracy, Coverage, Objectivity, Date, Significance (AACODS) checklist for appraising grey literature (Appendix 6). The systematic reviews (Appendix 3), the 'grey literature' research reports (Appendix 6), and the economic studies (Appendix 4) were classified as moderate or strong quality.

3.6.3 Question 4

Five papers[1, 50, 51, 32, 37] that provided data to answer Question 4 were not suitable for quality appraisal as they did not report the methods used. Two of the papers were theoretical and three were summaries of issues pertaining to assisted reproductive technologies; data from all five papers made a substantive contribution to answering our question. We drew data from four papers that had been grouped as economic papers; two were rated moderate and two were rated strong. Data were also taken from three systematic reviews; two were rated strong and one was rated moderate. Four papers that we grouped as qualitative provided data to answer this question; two were rated strong, one was rated moderate and one was rated weak. The qualitative studies were rated according to four criteria. Where a study met all four criteria (100%), it was rated strong. Where it met three criteria (75%), it was rated moderate, and where it met fewer than three criteria, it was rated weak. Data were also drawn from three quantitative studies; all three studies were rated moderate as they met three out of four criteria (75%). We also drew data from the 2013 National Institute for Health and Care Excellence (NICE) guidelines on infertility treatment, a report that we rated as the highest possible quality (Appendix 7).

3.7 Analysis

3.7.1 Question 1 and Question 3

The approach to analysis followed the approach taken in a number of other overviews of public funding mechanisms and criteria. The data are presented, using the Department of Health questions and the questions' guidelines, in tabular format. The data sources are referenced in the tables, and the text describes the main similarities and differences. We tended to use the most recent data for each country.

3.7.2 Question 2

The data were synthesized using the data extracted. Costs and benefits were identified. The costs to one party provide a benefit to another party. The benefits were mainly to the patient (opportunity to become pregnant), the provider (clinical experience and income) and society (additional members of society), whereas the costs were to the funder (the service itself and complications) and society (increase in public expenditure). Methods for controlling and deciding costs were also identified.

3.7.3 Question 4

We could not find any papers in the peer-reviewed literature we reviewed that have explicitly asked this question. Therefore, it was necessary to collect small pieces of relevant data from many papers to help us build a picture of the likely logic underpinning the selection of criteria in the countries covered in the papers reviewed. We analysed the papers using both inductive and deductive approaches. For example, we screened papers for the logic underpinning the selection of clinical criteria, i.e. the upper female age limit (deduction), and we found new codes during the review in the form of the demographic deficit and political and social concerns (inductive).

3.8 Strengths and limitations

In the search, we included literature from 2008 onwards. The data in some papers were collected up to four years prior to publication. We excluded low-income countries and concentrated mainly on Organisation for Economic Co-operation and Development (OECD) countries. We also excluded papers that were not in the English language. Due to time constraints, we searched one database, MEDLINE, which we would argue is the most relevant database.

3.8.1 Question 1 and Question 3

We present data published in peer-reviewed journals or international associations' reports that describe public funding mechanisms and criteria between 2008 and 2016. However, the data available are from different time points and the data are based on primary data collected between 2008 and 2016. All of the data are referenced to their source in the tables, so that the reader can check the time points. The data are taken from reports and papers published in English between 2008 and 2016. We were able to check data from

English-speaking countries with their original sources, but were not able to do this for non-English-speaking countries. Generally, the data we present were consistent between all sources and where the data were not consistent, usually there was a documented change in regulation or funding policy. When reading the answers to Questions 1 and 3, these strengths and limitations should be taken into consideration.

3.8.2 Question 2

We present data published mainly in peer-reviewed journals that were assessed as moderate or strong quality. The funding mechanism and funding criteria for assisted reproductive technologies are unique to each country. We cannot determine the ideal funding mechanism, in that we cannot say how much the state should pay for each publicly funded cycle, but we point to the different countries' public funding policies and their revisions and their learning through experience.

3.8.3 Question 4

The main limitation in our data in answer to Question 4 is the absence of any paper that had previously addressed this question. Consequently, our data are drawn from theoretical papers, summary discussions, economic papers, systematic reviews, qualitative policy analyses, qualitative primary studies and quantitative secondary analyses. In addition, our data are drawn from different sections within these papers, including the introduction. It could be argued that drawing on data from such a wide variety of sources, which are underpinned by contested epistemological terrain, may render any meaningful analysis problematic. On the other hand, we have acknowledged this limitation throughout the report and we have been careful in presenting our synthesis answer to Question 4 in primarily descriptive form with modest inferences. On this basis, we are satisfied that we have attempted to make a 'best fit' between the data collected and the question posed, and as such, we have been careful not to overstate our claims.

The papers from which we collected data were rated either strong or moderate, suggesting that they were well-designed studies with good analysis and are relevant to our question. However, in a lot of cases we did not take data from the findings in the papers; thus, it could be argued that their methodological quality was of little relevance. However, we suggest that their quality also speaks to their accuracy and reliability, and as we were collecting up-to-date factual information from the papers, accuracy and reliability are important attributes.

4 Background: assisted reproductive technologies

4.1 Infertility

The World Health Organization (WHO) defines infertility between heterosexual couples as lack of conception following one year of unprotected sexual intercourse. The European Society of Human Reproduction and Embryology's (ESHRE) 2014 fact sheet reported that one in six couples worldwide experience some form of infertility problem at least once during their reproductive lifetime.[52] The current prevalence of infertility lasting for at least 12 months is estimated to be around 9% worldwide for women aged between 20 and 44 years, and research into the causes of infertility indicates that:

- Between 20% and 30% of infertility cases are explained by physiological causes in men.
- Between 20% and 35% of infertility cases are explained by physiological causes in women.
- Between 25% and 40% of infertility cases are because of a problem in both partners.
- In between 10% and 20% of cases, no cause is found.

The European Society of Human Reproduction and Embryology reported that infertility is also associated with lifestyle factors such as smoking, body weight and stress. Increasing age in the female partner is one of the most common explanations today.[52] In 2011, it was estimated that more than five million babies were born worldwide since the first in vitro fertilization baby was born in 1978. Most medically assisted reproductive treatments take place in women aged between 30 and 39. [52]

4.2 Activity

The European Society of Human Reproduction and Embryology estimates that 55% of all reported medically assisted reproductive treatment cycles take place in Europe.[52] In 2011, the latest year for which figures are available, 588,629 treatment cycles were reported from 33 European countries. This compares globally (in 2011) with 151,923 cycles from the United States of America (USA) and 66,347 cycles from Australia and New Zealand. The number of cycles performed in many developed countries has grown by between 5% and 10% per year over the past few years. In 2011, France (85,433 cycles), Germany (67,596 cycles), Italy (63,777 cycles), Russia (56,253 cycles), Spain (66,120 cycles) and the UK (59,807 cycles) were Europe's most active countries. [52] In the Nordic countries, Sweden leads with 18,510 cycles, followed by Denmark with 14,578 cycles. The most active countries in the world are Japan and the USA;[7] the USA was excluded from Questions 1, 3 and 4 as these questions concentrate on public health services funding. Israel was not included in the Chambers *et al.* 2009 study.[7]

4.3 Availability

The European Society of Human Reproduction and Embryology reports that the Nordic countries, Belgium, Iceland and Slovenia have the highest assisted reproductive treatments availability in terms of cycles per million population in 2011.[52] In Belgium, the Czech Republic, Denmark, Estonia, Iceland, Norway, Slovenia and Sweden, more than 3% of all babies born were conceived by assisted reproductive technologies. By contrast, the proportion in the USA, with 61,610 assisted reproductive technology babies born, was estimated to be slightly more than 1% of total births, and in Israel it was estimated at 4.2% of total births.[38] Around 1.5 million assisted reproductive technology cycles are performed each year worldwide, with an estimated 350,000 babies born subsequent to IVF treatment. The USA only meets 24% of demand, whereas Australia, Denmark, Norway and Sweden meet 100% of demand; the latter four countries are those that had the lowest out-of-pocket expenses in 2009.[7] Demand is calculated as 1,500 couples per million of the population. Israel is not included in Chambers *et al.*'s 2009 study.

4.4 Costs

The cost of a fresh in vitro fertilization cycle was 28% of the gross national income per capita in the USA in 2006 and only 10% of the gross national income per capita in Japan. Of note, costs associated with assisted reproductive therapies often reflect the underlying costs of the healthcare system, which is why the USA is something of an outlier. The cost as a percentage of the gross national income in the UK was 19%, in Australia 18% and in Scandinavia 14%.[7] In 2006, the average cost of assisted reproductive therapy treatment as a percentage of annual disposable income (allowing for subsidies) was 44% in the USA, 12% in the United Kingdom (UK), 11% in Scandinavia and 6% in Australia.[7] In 2003, the total cost of assisted reproductive therapy as a percentage of total healthcare expenditure was 0.06% in the USA, 0.13% in the UK, 0.19% in Scandinavia and 0.25% in Australia.[7] Of note, the total cost of assisted reproductive therapy as a percentage of total healthcare expenditure in Israel is 1.8%.[4]

4.5 Pregnancies and delivery rates

Pandian *et al.*[53] undertook a Cochrane review to examine the evidence about the number of embryos transferred in women undergoing in vitro fertilization or intracytoplasmic sperm injection. They included 14 randomised controlled trials with a total of 2,165 participants. Repeated single-embryo transfer appears to be the best option for most women undergoing such treatments. In a single fresh in vitro fertilization cycle, single-embryo transfer is associated with a lower live birth rate than double-embryo transfer. However, there is no evidence of a significant difference in the cumulative live birth rate when a single cycle of double-embryo transfer is compared with two cycles of single-embryo transfer. Most of the evidence currently available concerns younger women with a good prognosis.

The European Society of Human Reproduction and Embryology's analysis of world data for 2006 put the average delivery rate from assisted reproductive technology treatment at 21%

per aspiration and 25% cumulative from a single started treatment cycle.[52] Large differences exist between countries in the number of embryos transferred and resulting in multiple births, and these differences are important to understand in designing a public payment system. However, there is a consistent trend towards the transfer of fewer embryos that is often linked to reimbursement and regulated embryo transfer rates (such as those in Belgium, New Zealand). The overall average number was 1.75 embryos per transfer in 2011. In Europe, the multiple birth delivery rate has declined steadily, from 26.9% in 2000 to 19.4% in 2011, compared with a multiple birth delivery rate of 30% in the USA (27.5% twin and 2.5% triplet or more birth deliveries). In 2011, Sweden has the lowest multiple birth delivery rates in Europe (5.6%). In 74.7% of all cases a single embryo was transferred. In Europe in 2011, the mean pregnancy rate per embryo transfer was 33.2% after in vitro fertilization, 31.6 % after intracytoplasmic sperm injection, 23.4% after frozen embryo transfer, and 47.5% after egg donation. Rates are higher in younger patients (<35 years). Ireland tends to follow the European average rates for pregnancy and delivery rates. In Australia,[8] there was a 54% reduction in multiple birth delivery rates following assisted reproductive technologies, from 18.8% of deliveries in 2002 to 8.6% in 2008, as a result of encouraging single-embryo transfer.

4.6 Treatments

In 2015, Farquhar and colleagues completed a Cochrane review, which is an umbrella review of all existing Cochrane systematic reviews, on the effectiveness of assisted reproductive technologies.[54] This is a complex topic outlining what treatments are effective, promising, ineffective, or have not enough randomised trials to make a judgement on effect. We present a link to this review in the reference section of the document.

The European Society of Human Reproduction and Embryology reported that the most common fertilization (treatment) technique is intracytoplasmic sperm injection (ICSI), a form of in vitro fertilization.[52] Overall, intracytoplasmic sperm injection accounts for approximately two-thirds of all treatments worldwide and conventional in vitro fertilization accounts for around one-third. However, these proportions vary greatly between countries, even though outcome rates with each technique are comparable. Success rates from frozen embryo transfer are increasing, as are the number of frozen embryo replacement cycles. Vitrification, as an efficient cryopreservation technique, has improved the outcome of both embryo and oocyte freezing.

4.7 Compliance with and discontinuing fertility treatment

Gameiro *et al.*[55] report on a review which included 22 studies that sampled 21,453 patients from eight countries. The most common reasons for discontinuation of fertility treatment were: postponement of treatment (39.2%), physical and psychological burden (19.1%), relational and personal problems (16.7%), treatment rejection (13.2%), organisational problems (11.7%) and clinic problems (7.7%). Some reasons were common across stages

(e.g. psychological burden) whereas others were stage-specific (e.g. treatment rejection during workup).

Gameiro *et al.* [55] undertook a comprehensive search of seven databases. Longitudinal and/or cross-sectional studies were included if they reported on the number of patients who discontinued fertility treatment and on patients' stated reasons for discontinuation or predictors of discontinuation (assessed prior to the occurrence of discontinuation behaviour). An appropriate evaluation of study quality was undertaken.

According to Gameiro *et al.* [55] '…The emotional distress caused by the treatment failure and the necessity to choose future treatment can also explain why patients postpone treatment… Indeed, more than delaying their decision, patients may be avoiding it to manage or prevent negative emotional reactions…' p665.

Gameiro *et al.* [55] go on to say that '…Financial issues were only reported in studies from Canada and North America where fertility care is not (or was not) covered by the national health systems. These results indicate that financial issues can be an important barrier to compliance in fertility treatment and that there is still worldwide inequality in the costs of fertility treatment…' p666.

Gameiro *et al.* [55] stated that '…This is the first systematic review to synthesize more than 20 years of research on discontinuation… The research on what the systematic review was based on was of average to high quality. Despite these strengths, several limitations of the reviewed literature exist: reason descriptors were vague and insufficient to capture all reasons for discontinuation; research on predictors of discontinuation was of low power, and neglected patient and clinic predictors and studies varied in how they defined the group of patients considered to have discontinued treatment. Although these limitations need to be acknowledged, the results presented are in line with the only longitudinal cohort study that investigated reasons at different treatment stages taking these issues into account, thus reinforcing that this systematic review presents a reliable overview of the current best available evidence about discontinuation from fertility treatment…' p667.

Gameiro also led another systematic review, which was published in 2013.[56] It estimated the rate of compliance with assisted reproductive technologies and examined its relationship with treatment success rates. The authors undertook a comprehensive search of six databases for papers published between 1978 and December 2011. Studies were included if they reported data on patient progression through three consecutive standard assisted reproductive technology cycles. Ten studies with data for 14,810 patients were included.

Gameiro *et al.* (2013) [56] reported that '…the vast majority of patients will comply with the typical assisted reproductive technologies regimen of three cycles, with about 2 of 10 patients discontinuing treatment earlier than would have been expected… doctors can expect that 78% of patients will opt to undergo their assisted reproductive technology regimen until they achieve pregnancy or are advised to end treatment. Compliance is likely to decrease with increasing assisted reproductive technology failure, from 82% after the first failed cycle to 75% after the second failed cycle, but the decrease does not seem to be a

function of the efficacy of the clinic… in every 100 typical couples starting assisted reproductive technologies treatment, 78 comply with three cycles, and of these, 43 can expect to achieve pregnancy or live birth. However, if full compliance could be reached, 58 patients would achieve a pregnancy or live birth, which represents a 15% higher rate of success (if all other factors, including prognosis, are equal across three assisted reproductive technology cycles). Therefore, addressing causes of non-compliance could help more people become parents, with a maximum estimated increase in success rates of 15%…' p133.

The authors undertook a quality assessment of the included studies and reported that '…All studies were… of moderate to high quality and the quality of the studies was due to the fact that all used representative samples, and most studies could demonstrate homogeneity between compliers and non-compliers at the start of treatment and provided high completion rates for follow-up…' p134.

4.8 Complications

Multiple pregnancies mean an increased risk of premature birth and perinatal death, and occur mainly in older patients when multiple embryos are transferred to increase the chance of pregnancy.[52] Ovarian hyperstimulation syndrome is a complication related to assisted reproductive technologies. In 2011 there were 1,683 ovarian hyperstimulation syndrome cases recorded in 28 out of 33 European countries reporting to the European Society of Human Reproduction and Embryology, making up 0.6% of cycles. Russia (520), Italy (189) and Spain (184) reported the highest number of patients with ovarian hyperstimulation syndrome.

In one study in Sweden, women who had previously undergone in vitro fertilization treatment were at increased risk of symptoms of depression ($p=0.017$), obsessive-compulsion ($p=0.02$) and somatization ($p<0.001$) when compared with a reference group. In addition, the women who had remained childless were at increased risk of symptoms of depression ($p=0.009$) and phobic anxiety ($p=0.017$).[57]

A study in the UK reported that campaigns for the widespread introduction of single-embryo transfer may not only reduce the incidence of multiple pregnancies but also the incidence of ectopic pregnancy following in vitro fertilization/intracytoplasmic sperm injection.[58]

4.9 Monitoring and evaluation

Watt *et al*. recommend that monitoring systems move from a cycle-based reporting system to a person-based reporting system to determine person-based immediate outcomes.[43] Authors also point to the lack of evidence on long-term maternal and child outcomes and the need for a long-term prospective cohort study.[37, 40, 43] However, births as a result of in vitro fertilization are more likely to have congenital abnormalities than naturally conceived children.[59]

4.10 Public attitudes to infertility and assisted reproductive technologies

The national practice of assisted reproductive technologies is shaped by national political, social and religious histories. A German survey [50] of over 3,000 people, representing a range of stakeholders, found three 'major normative convictions' to be 'statistically associated with support for [complete] public funding':

- Infertility is a disease.
- Having children is a basic opportunity every human should have.
- Infertile couples with an unfulfilled desire for children are usually in need of assisted reproduction.

The German respondents indicated that medical and social infertility equally necessitate treatment. Carter and Braunack-Mayer study 'argues that those suffering "merely" social infertility do not represent appropriate candidates for assisted reproductive treatment, while another view limit their arguments to the context of public funding for assisted reproductive technologies.'[50] Explanations for limited funds for assisted reproduction include the perception of infertility as a low health priority and the questioning of infertility as an illness within the wider healthcare framework.[12]

4.11 Professional attitudes to infertile patients and their requests

Záchia *et al.*[60] studied the factors (including cultural) prioritized by professionals when deciding on whether to perform assisted reproduction. This cross-sectional study involved 224 healthcare professionals working with assisted reproduction in Brazil, Italy, Germany and Greece. Two hundred and twenty-four health professionals responded to the survey: 51.1% Brazilians; 22.2% Germans; 17.7% Italians; and 8.4% Greeks. The sociodemographic characteristics of the professionals who participated in the study were as follows: 71% were male; 84% were physicians; 13% were biologists; 84% were living with a partner; and 76% had children of their own.

Case 1: A single middle-class woman with no intention of having a male partner in the future.
Case 2: A non-infertile couple requests a homologous insemination because the woman is HIV positive.
Case 3: A heterosexual couple, who have two male children, wish to have another child. The woman has a tubal problem and is unable to conceive. The couple would only like female embryos to be implanted.
Case 4: A lesbian couple request that the clinician obtain an oocyte from one of the partners to be fertilized with semen from a sperm bank. The embryo should then be transferred to the other partner who will act as a surrogate, so that both can participate actively in the process.

Only the case involving a single woman who wishes to have a child (without the intention of having a partner in the future) led to the respondents questioning her suitability for treatment.

4.12 Postponing parenthood

Mills *et al.*,[61] following their review of the literature, reported that there is clear empirical evidence of postponement of attempts to conceive the first child. Central reasons are the rise of effective contraception, increases in women's education and employment, changes in male-female partnership, gender equity, high cost of housing, economic and employment uncertainty, and the absence of supportive family policies. The authors say that 'the evidence suggests that policies aimed at reducing the incompatibility between work and mother roles (e.g. maternity leave, childcare, early education) are more effective and lead to younger ages at first birth.' The authors also found that 'broader culture and attitudes such as the level of family-friendliness of a society are important. Policies cannot be considered in exclusion, but are part of a wider message sent to individuals about whether they can have and sustain parenthood in the longer term.' p857. There is some suggestive evidence in the annual European Society of Human Reproduction and Embryology data that countries with higher levels of reimbursement have younger average ages for first in vitro fertilization cycle. This would suggest that without publicly funded access couples may have to wait longer to receive treatment as they accumulate financial resources to pay for treatment. As age is crucial to success, an extended waiting period will diminish treatment success.

Mills *et al.* (2011)[61] reported a comprehensive search strategy with clear inclusion and exclusion criteria; the authors included 139 studies in the final narrative synthesis. The authors acknowledged the empirical difficulties of establishing policy effects due to the broad range of policy instruments, temporal lags between policy initiation and take-up, endogeneity issues and difficulties in distinguishing between policy effects on the level or timing of fertility. The authors also acknowledge that a central debate within the social policy literature surrounds methodological difficulties in directly measuring policy impacts on childbearing postponement. The authors do not report on quality assessment of studies.

5 Findings

5.1 Question 1: Describe the public funding mechanisms for assisted reproductive technology (ART) operated in a number of jurisdictions.

5.1.1 Introduction

We present data published in peer-reviewed journals or international associations' reports that describe public funding mechanisms and criteria. However, the data are from different time points and are based on primary data collected between 2008 and 2015. All the data in the tables are referenced to their sources so that the reader can check the time points. The data are taken from reports and papers published in English. We were able to check data from English-speaking countries with the original sources, but were unable to do this for non-English-speaking countries. Generally, the data we present are consistent between all sources and where the data are not consistent, usually there was a documented change in regulation or funding policy. This chapter should be read bearing these strengths and limitations in mind.

5.1.2 Assisted reproductive technologies: public funding mechanisms

Most EU member states have deemed infertility a medical condition and have made provisions within their national policies to fund all or some portion of infertility treatment. However, restrictions usually apply and these are addressed in presenting the evidence in response to Question 3 (see Section 5.3).

In Ireland, a defined list of fertility medicines required for fertility treatment is covered under the public health service's High Tech Scheme administered by the Health Service Executive.[62] Medicines covered by the High Tech Scheme must be prescribed by a consultant or specialist and approved by designated Health Service Executive staff. The cost of the medicines is covered under either the Medical Card (€2.50 user fee per drug per month) or the Drugs Payment Scheme (the patient pays the first €144 per month). In addition, individuals who are in employment and pay income tax can claim a tax credit on 20% of their out-of-pocket expenses. GloHealth, Laya Healthcare and Voluntary Health Insurance are the only three insurers in Ireland that offer some cover for assisted reproductive services; Aviva does not cover infertility treatments. GloHealth members receive a 10% discount on fertility treatment at one fertility treatment centre under some personalized plans. Laya covers up to a maximum of €1,000 per female recipient and Voluntary Health Insurance covers infertility treatment at an approved centre up to €2,500 per lifetime for members of the VHI PMI 0411 plan, which is only one of its many plans. Health insurance entitlements must be

spent before medication subsidies from the Health Service Executive can be claimed. The insurance cover offered by each insurance company was accessed on their websites on 19 April 2016.

The UK, Belgium, France, Slovakia, Slovenia and Spain (only for women aged <40 years) offer '**full public funding** through the health services' to eligible couples or individuals (Table 4); full coverage in this context is defined as more than 81% coverage of at least one cycle of intrauterine insemination and/or in vitro fertilization or intracytoplasmic sperm injection. In 2013, a new policy was introduced in Poland that entitled couples to undergo infertility treatment for at least one year with a refund of the total cost,[63] but a new conservative government then came to power and intended on discontinuing public funding at the end of June 2016.[63]

Nineteen countries (Austria, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Iceland, Italy, Latvia, the Netherlands, Norway, Portugal, Spain [for women aged >40 years], Sweden and Turkey) offer **partial public funding** through the national health plan, and the remainder of the costs are borne by the individuals; partial coverage in this context is defined as less than 81% coverage of at least one cycle of intrauterine insemination and/or in vitro fertilization or intracytoplasmic sperm injection. The public funding situation in Russia is unclear, with some sources reporting full funding and others reporting that there is no public funding.

Outside Europe, Israel and New Zealand provide full coverage through their national health services, whereas Australia offers partial funding. Ontario in Canada provides full funding for one cycle through its provincial health plan. Like Ireland, the province of Manitoba in Canada provides a tax credit for taxpayers to access assisted reproductive technologies. The current publicly funded assisted reproductive technologies programme was cancelled in November 2015 following an evaluation of its outcomes.

The countries that provide **partial public funding** require substantial **out-of-pocket payments** from patients. For example, Austria requires a 33% out-of-pocket payment whereas Denmark requires a contribution of €1,840 per cycle. Finland requires the patient to pay 25% of the costs of investigations, 40% of the medical specialist's fee and up to 58% of the medicines. Depending on the state, Germany requires the patient to pay between 25% and 50% of the total costs. Hungary requires patients to pay between 30% and 70% of the cost of gonadotrophic drugs. The situation in Portugal is not clear, but the patient must pay 31% of the cost of gonadotrophic drugs. In Slovakia, the patient pays for 25% of laboratory and drug costs. These partial funding arrangements imply that patients must either save or borrow a substantial amount of money in order to access public funding.

From the most recent data that were located, a small number of European countries provide **no public funding** from the national health plan: Cyprus, Lithuania, Malta, Romania and Switzerland. In 2011, the Ministry of Health in Romania set up a pilot programme partially funding limited numbers of in vitro fertilizations,[6] but the current status of the programme is unclear. In Cyprus, the Ministry of Finance contributes funding towards the laboratory and drug costs of assisted reproductive technologies, but the level of funding and

method for claiming funds are not described. Malta does provide assisted reproductive services in private clinics, but there is no public funding for such services.

Outside Europe, Japan has a means-tested subsidy. The USA does not provide public funding for assisted reproductive technologies. Approximately 12% of women of childbearing age have received assistance for infertility in the USA.[64] Between 1980 and 2014, 15 states (Arkansas, California, Connecticut, Hawaii, Illinois, Louisiana, Maryland, Massachusetts, Montana, New Jersey, New York, Ohio, Rhode Island, Texas and West Virginia) passed laws that require insurers to either cover or offer coverage for infertility diagnosis and treatment. Thirteen states passed laws that require insurance companies to cover infertility treatment. Louisiana and New York prohibit the exclusion of coverage for a medical condition otherwise covered solely because the condition results in infertility. California and Texas have laws that require insurance companies to offer coverage for infertility treatment. Utah requires insurers providing coverage for maternity benefits to also provide an indemnity benefit for adoption or infertility treatments. While most states with laws requiring insurance companies to offer or provide coverage for infertility treatment include coverage for in vitro fertilization, California, Louisiana and New York have laws that specifically exclude coverage for the procedure.[64]

Since 2008, the number of countries providing some public funding has increased, but the funding practice has changed and the main change noted was a reduction in public funding per patient treated and increased out-of-pocket payments for patients.

Table 4 Public funding for assisted reproductive technologies, by country, 2009–2015

Country	Overall funding of assisted reproductive technologies (ARTs)
Australia	Public funding partial.[65] Under the Australian Medicare system, each patient receives a set amount of reimbursement towards the cost of an assisted reproductive technology cycle.[65] Medicare payments were capped for each treatment type in 2010 and user out-of-pocket fees increased by between 300% and 400%, increasing from 20% out-of-pocket payment to a 70% payment. This was done to control medical inflation and made funding more sustainable.
Austria	Public funding partial.[65, 66] Two-thirds of costs covered by national health system,[65, 66] or 70% of the costs of in vitro fertilization treatments under specific conditions.[67]
Belgium	Public funding is full for in vitro fertilization and intrauterine insemination, with a small out-of-pocket charge, but partial for other services.[67] Public funding is classified as partial in some reports.[65, 66] Funding is regulated by law.[65]
Bulgaria	Public funding partial.[65, 66] Assisted hatching, magnetic activated cell sorting, cryostorage, and use of anonymous donor sperm are not covered.[65] In 2004, in vitro fertilization was included for the first time in the range of health services covered by the National Health Insurance Fund and covers hormonal drugs but not tests or procedures.[1] Since 2009, a woman can be paid up to BGN5,000 or

Country	Overall funding of assisted reproductive technologies (ARTs)
	approximately €2,500 for one in vitro fertilization cycle and the amount will cover both the medicaments and the procedure itself. If the total value is over BGN5,000, the difference will be covered by the patient.[1]
Canada (Manitoba)	Fertility treatments eligible under the tax credit scheme include ovulation induction, therapeutic donor insemination, hyperstimulation/intrauterine insemination, in vitro fertilization, intracytoplasmic sperm injection, oocyte donation, assisted hatching, fertility preservation, surrogacy and testicular sperm extraction. Ineligible procedures include reversal of vasectomies and tubal ligations.[68, 69]
Canada (Ontario)	Ontario contributes to the funding of one cycle of fertility preservation per eligible patient requiring sperm or egg preservation for medical reasons. In addition to in vitro fertilization, fertility preservation and artificial insemination procedures, various laboratory, embryology and other supporting services are funded under a provincial public funding programme.[70]
Croatia	Public funding partial.[65, 66]
Cyprus	The Ministry of Finance provides funding towards the laboratory and drug costs of assisted reproductive technologies in Cyprus,[49, 67] but the level of funding or method for claiming funds is not described.
Czech Republic	Public funding partial.[65, 66] Some procedures (such as embryo freezing, frozen embryo transfer, extended culture) and medication require co-payments by an infertile couple .[65]
Denmark	Public funding full.[65, 66] In June 2010 the Danish Government signaled its desire to cut funding for both assisted and non-assisted artificial reproduction treatments[12] and did so in January 2011.[67] Patients must make a co-payment unless they require treatment that includes preimplantation genetic diagnosis and this treatment must be done in a public hospital.[67] The reimbursement is possible for the first child only and the woman has to be under 40 years of age. For the second child, the couple has to pay full price for the treatment in a private clinic, but there is reimbursement for the medication.[65]
Estonia	Public funding partial.[65, 66] 100% of treatment costs and 60% of medication costs are covered.[65]
Finland	Public funding partial.[65, 66] Medication partly covered by both private and public clinics. Public clinics provide 40% of assisted reproductive technology cycles. Private treatments are partly reimbursed by social insurance (up to the age of 42 years).[65] Sixty per cent of all in vitro fertilization treatments are provided by private services;[27] the national health insurance fund pays 60% of the doctor's fee, and part of the costs of the investigations and 50% of the medications are paid for by the Social Insurance Institution.[27] Overall, patients attending private centres pay 50% of the total costs and public patients pay 24% of the total costs.[27] Private health insurance companies in Finland are required by law to cover infertility treatments where the infertility is as a

Country	Overall funding of assisted reproductive technologies (ARTs)
	result of an illness.[67]
France	Public funding is full[65, 66] for four cycles of in vitro fertilization.[65]
Germany	Public funding is partial and is between 50% and 75% depending on state. User fees have been imposed since 2004. Between 2004 and 2012 patients paid 50% of the costs of assisted reproductive technologies. On 2 March 2012, the Federal Council approved a draft law whereby the federal government provides a subsidy of 25% of the costs, reducing the share of costs borne by each couple to just 25%.[71] Six of the 16 federal states participate in this scheme.[67] Statutory health insurance only covers services for married couples.[67]
Greece	Public funding partial.[65, 66] Public funding covers medication expenses (under conditions and with patient contribution) and approximately €350 towards medical and laboratory expenses.[65] The exact amount depends on the person's social security organization.[3]
Hungary	Public funding is self-described as full,[65, 66] but if drugs are considered public funding, it is partial. Five cycles with embryo transfer are totally covered irrespective of the number of earlier pregnancies. Drugs are reimbursed at different rates, varying from 0% to 70%:[65] – GnRH analogues: 0% – FSH/hMG, LH: 70% – Progesterone: 30%
Iceland	Public funding partial.[65-67]
Ireland	No public funding;[65, 66] assisted reproductive treatments are not financially supported by the public health service but there is a tax credit.[65] If drugs are included as an aspect of public funding, funding is partial. The cost of drugs is covered (after the first €144 each month, which is paid by the patient). In Ireland, a defined list of fertility medicines required for fertility treatment is covered under the public health service's High Tech Scheme, administered by the Health Service Executive.[62] Medicines covered by the High Tech Scheme must be prescribed by a consultant or specialist and must be approved by designated Health Service Executive staff. The cost of the medicines is covered under either the Medical Card (€2.50 user fee per drug per month) or the Drugs Payment Scheme (the patient pays the first €144 per month). In addition, individuals who are in employment and pay income tax can claim a tax credit to the value of 20% of their out-of-pocket expenses.
Israel	Public funding full[65] if, according to in vitro fertilization law, special medical indications exist. Coverage is provided for up to two live births.[65]
Italy	Public funding partial.[65, 66] Regional variations.[3] Treatments performed within the national healthcare system are totally or partially reimbursed, according to criteria defined by each region. The budget available at a national level, however, can only cover 50% of treatments.[65]

Country	Overall funding of assisted reproductive technologies (ARTs)
Japan	Japan has universal coverage for health insurance, and medical co-payments are usually 30%. Artificial reproductive procedures are not covered and were done at a patient's own expense until 2004, when the government introduced a means-tested subsidy. Only couples whose annual household income is lower than ¥7,300,000 (approximately US$83,000) are eligible for the subsidy. Until March 2013, up to ¥150,000 was provided for support per cycle of autologous in vitro fertilization (50% of cost), intracytoplasmic sperm injection or frozen embryo replacement. Since April 2013, the upper limit of the subsidy for frozen embryo replacement or failed oocyte retrieval has been reduced to ¥75,000, but the other subsidies remain unchanged. Assisted reproductive technologies are provided for up to two cycles annually for five years, and up to 10 times in total. There are no other eligibility criteria for accessing the subsidy, such as the woman's age or causes of infertility.[28]
Latvia	Public funding partial.[66] Depending on age it may be partial or complete.[65] The programme started in November 2012 and by the end of 2013, 50 cycles had been completed.
Lithuania	There is a public funding programme,[67] but the level of funding provided is not published in any of the documents searched.
Luxembourg	No information found.
Malta	The country appears to investigate fertility and treat its causes,[67] but does not provide assisted reproductive technologies under its public health service.
The Netherlands	All primary and curative care (i.e. the family doctor service and hospitals and clinics) is financed from private compulsory health insurance. Most private insurance companies also pay for three in vitro fertilization cycles[72] but charge a co-payment. Following changes to coverage in 2013, the patient must pay for the first cycle and the private compulsory health insurance will pay for the subsequent two cycles.[67]
New Zealand	Full cover if people meet eligibility criteria.[65] The service excludes people who do not meet the access threshold for publicly funded assisted reproductive treatment. [73] Public funding depends on geographic location: in some areas, drugs are funded and in others, co-payment is required.[72] The numbers of the population who can access the service depends on regional health funding and there are substantial waiting lists.[72] Waiting lists vary from one to three years. Individuals using private services are generally not covered under personal health insurance policies and have to pay from their own pockets.[72] No co-payment is sought from service users for any service covered by the assisted reproductive technology service specification, including supplies and equipment. The exceptions are service users who receive embryo storage services. Embryo storage services for infertility must be paid for by the client after the initial 18 months of storage, and embryo storage services for fertility preservation must be paid for by the client after the initial 10

Country	Overall funding of assisted reproductive technologies (ARTs)
	years of storage.[73] Embryo transfers for purposes of gestational surrogacy are not covered.[71]
Norway	Public funding partial.[65, 66] In 2004, the user fee in a public clinic for an assisted reproductive technology cycle was between €190 and €256,[40] but more recent data indicate that by 2013, patients at governmental units were paying up to €2,500 (16,700 Norwegian Krone) for up to three treatment cycles,[65, 67] with the state paying the remainder. This highlights the large increase in co-payments over the period. The national health plan is funded through local taxes.[65, 66]
Poland	In 2013, a new policy was introduced in Poland that entitled couples to undergo infertility treatment for at least a year with a refund of the total cost,[63] but a new conservative government then came to power and intended on discontinuing public funding at the end of June 2016.[63]
Portugal	Public funding partial[65, 66] for a maximum of three treatments.[65] 69% of costs of medications are covered.[35]
Romania	Patients must pay the first €2,000 of assisted reproductive technology treatment costs.[65] This is a pilot project.
Russia	The information is contradictory. Public funding full.[65, 66] The federal government paid for 10,000 cycles in 2011 and 2012, with 31.6% of these being done in state clinics (out of a total of 39,988 cycles in the country). Most of these treatments were paid for from regional or federal budgets.[65] Public funding partial.[67] Mandatory medical insurance covers screening and some tests. However, in general, patients fund their own treatment.[67]
Slovakia	Public funding full for two cycles.[49, 67]
Slovenia	Public funding full.[65, 66] Six cycles for the first child, and four cycles after the first live birth up to the age of 42 years.[65, 66]
Spain	Public funding full[65, 66] up to the age of 40 years.[66] Regional variations.[3]
Sweden	Public funding partial.[65, 66] Of the total cost, 60% is paid publicly and 40% is private or 'out-of-pocket' money. Private health insurance does not cover assisted reproductive technologies.[65] Public fertility clinics provide most necessary treatments and initial work-up, but there are long waiting lists,[3] especially for egg donations, since the donor is reimbursed only the same amount that the receiving couple is charged for the egg. Recent information indicates that there are private fertility clinics,[71] but it is unclear if they are used to provide publicly funded treatments.
Switzerland	No Public funding.[65, 66]
Turkey	Public funding partial.[65, 66]
UK England	Public funding full[74] and partial.[65, 66] The information is contradictory as the service users may have to pay some of the costs of the medicines. Funding through the National Health Service is variable throughout

Country	Overall funding of assisted reproductive technologies (ARTs)
	England and Wales. Postcode lottery still in place.[3, 65] In theory, women of a certain age have a right to assisted reproductive technology, but this policy is often modified by local clinical commissioning groups, in breach, according to the literature, of the *NHS Constitution for England*, which provides that patients have the right to drugs and treatments that have been recommended by NICE for use in the NHS.[75]
UK Scotland	Public funding full.[76]

5.1.3 Assisted reproductive technologies: reimbursement requirements

Denmark, Spain, Sweden and UK England fund those **treated at public clinics** (Table 5).

The **total annual funding is set at a fixed amount** in seven countries (Austria, Belgium, Bulgaria, Czech Republic, Hungary, Slovenia and UK England).

In six countries (Australia, Austria, Germany, Greece, Latvia and Spain), the **patient must claim a reimbursement** for assisted reproductive technologies from the national health plan, which implies that the patient may need to pay the provider from their own resources before the reimbursement is issued.

In 11 countries (Bulgaria, Czech Republic, Denmark, Hungary, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Sweden and the UK) the **provider is paid directly by the national health plan**, meaning patients pay their out-of-pocket contribution only.

In five countries (Belgium, Estonia, Finland, France and Italy) the **provider can be paid by either by the patient or the national health plan**.

Table 5 Public or tax-based funding mechanisms (excluding private health insurance) for artificial reproductive technologies, by country, 2009–2015

	In order to have reimbursement for artificial reproductive technologies from public health services budget, treatment must be provided by public clinic.	Total number of publicly supported artificial reproductive technology cycles funded nationally is fixed by health services commissioners at the start of the year and cannot be changed.	Who is reimbursed for artificial reproductive technologies? – Patient – Provider – Both mechanisms allowed – No reimbursement allowed
Australia	No[43]	Not fixed (uncapped from Medicare)[18]	Patient[8]
Austria	No[49]	Fixed[49]	Patient only[49]
Belgium	No[49]	Fixed[49]	Both mechanisms allowed[49]
Bulgaria	No[49]	Fixed[49]	Provider only[49]
Canada (Ontario)	No, but in a nominated clinic	Not specified	Not specified
Canada (Quebec)	No information	No information	No information
Croatia	No information	No information	No information
Cyprus	Not applicable[49]	Not applicable	Not applicable
Czech Republic	No[49]	Fixed[49]	Provider only[49]
Denmark	Yes[49]	Can be revised depending on need[49]	Provider only[49]
Estonia	No[49]	Can be revised depending on need[49]	Both mechanisms allowed[49]
Finland	No[27]	Not specified[49]	Both mechanisms allowed [49]
France	No[49]	Can be revised depending on need[49]	Both mechanisms allowed[49]
Germany	No[49]	Unlimited[49]	Patient only[49]
Greece	No[49]	Can be revised depending on need[49]	Patient only[49]
Hungary	No[49]	Fixed[49]	Provider only[49]
Iceland	No information	No information	No information
Ireland	Not applicable[49]	Not applicable[49]	Not applicable[49]
Israel	No information	No; unlimited funding for in vitro fertilization or intracytoplasmic sperm injection[4]	No information
Italy	No[49]	Can be revised	Both mechanisms

	In order to have reimbursement for artificial reproductive technologies from public health services budget, treatment must be provided by public clinic.	Total number of publicly supported artificial reproductive technology cycles funded nationally is fixed by health services commissioners at the start of the year and cannot be changed.	Who is reimbursed for artificial reproductive technologies? – Patient – Provider – Both mechanisms allowed – No reimbursement allowed
		depending on need[49]	allowed[49]
Latvia	No[49]	Unlimited[49]	Patient only[49]
Lithuania	Not applicable[49]	Not applicable[49]	No reimbursement allowed[49]
Luxembourg	No,[49] but elsewhere in the same report they say that it has public clinics only.	Can be revised depending on need[49]	No information
Malta	Not applicable[49]	Not applicable[49]	No reimbursement allowed[49]
The Netherlands	No,[49] but elsewhere in the same report they say that it has public clinics only.	Not specified	Provider only[49]
New Zealand	No[77]	Not specified	Not specified
Norway	Yes[65]	No information	No information
Poland	No[49]	Can be revised depending on need[49]	Provider only[49]
Portugal	No[49]	Can be revised depending on need[49]	Provider only[49]
Romania	Not applicable[49]	Not applicable[49]	No reimbursement allowed[49]
Russia	Situation unclear	No information	No information
Slovakia	Situation unclear	Can be revised depending on need[49]	Provider only[49]
Slovenia	No,[49] but elsewhere in the same report they say that it has public clinics only.	Fixed[49]	Provider only[49]
Spain	Yes[49]	Can be revised depending on need.[49]	Patient only[49]
Sweden	Yes[49]	Can be revised	Provider only[49]

	In order to have reimbursement for artificial reproductive technologies from public health services budget, treatment must be provided by public clinic.	Total number of publicly supported artificial reproductive technology cycles funded nationally is fixed by health services commissioners at the start of the year and cannot be changed.	Who is reimbursed for artificial reproductive technologies? – Patient – Provider – Both mechanisms allowed – No reimbursement allowed
		depending on need[49]	
UK England	Yes[49]	Fixed[49]	Provider only[49]
UK Scotland	No information	No information	No information
UK Wales	No information	No information	No information

5.1.4 Assisted reproductive technologies funded through national health plans

Table 6 presents the status and public funding available for a range of assisted reproductive technologies by country, namely, **in vitro maturation**, **preimplantation genetic diagnosis**, **assisted hatching**, and **sperm** or **oocyte donation.**

Seven countries (Denmark, France, Slovenia, Sweden and the UK [England, Scotland and Wales]) fund or partially fund **in vitro maturation** through their national health plans. Twenty-two countries (Australia, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Greece, Hungary, Israel, Italy, Latvia, New Zealand, Norway, Russia, Slovenia, Spain, Sweden, UK [England, Scotland and Wales]) fund or partially fund **preimplantation genetic diagnosis** through their national health plans.

There is no documentary evidence that the costs of **assisted hatching** are paid for through public funding, and neither is there documentary evidence that **sperm** or **oocyte donation** for in vitro fertilization is funded through a national health plan.

Table 6 Status and public funding available for a range of assisted reproductive technologies, by country, 2009–2016

Country	In vitro maturation (IVM) allowed Yes/No	In vitro maturation reimbursed Yes/No	Preimplan-tation genetic diagnosis (PGD) allowed Yes/No	Preimplan-tation genetic diagnosis reimbursed Yes/No	Assisted hatching allowed Yes/No	Assisted hatching reimbursed Yes /No	Sperm donation for in vitro fertilization (IVF) permitted Yes/No	Sperm donation for IVF reimbursed Yes /No	Oocyte donation permitted Yes/No	Oocyte donation reimbursed Yes /No	Embryo donation allowed Yes/No
Australia	Yes[65]	No information	Yes, in law and in guidelines[65]	Yes[65]	Yes, in law and in guidelines[65]	No	Yes, in law[65]	Not clear but is likely to be funded	Yes, in law[65]	Not clear but is likely to be funded	No information
Austria	Yes,[49, 65] in practice	No[49]	No[49]	Not applicable[49] Yes[65]	Yes[16]	No information	Yes[67]	Not known	Yes[67]	Not known	Not allowed in law[3]
Belgium	Yes,[49, 65] in practice	No[49]	Yes,[49] in law[65]	Yes[49, 65]	Yes[16]	No information	Yes, in law[3, 65]	No information	Yes, in law[3, 65]	No information	Yes, in law[3]
Bulgaria	Yes,[49] in law[65]	No [49]	Yes,[49] in law[65]	No[49] Yes[65]	Yes, in law[65]	No[65]	Yes, in law[65]	Not stated	Yes, in law[65]	Not stated	No information
Croatia	Not specified[65]	No information	Not specified[65]	No[65]	Not known[65]	No information	Yes, in law[65]	No information	Yes, in law[65]	No information	No information
Cyprus	Yes[49]	No[49]	Yes[49]	Yes[49]	No informatio	No information	No informatio	No informatio	No informatio	No informatio	No informatio

Country	In vitro maturation (IVM) allowed Yes/No	In vitro maturation reimbursed Yes/No	Preimplan-tation genetic diagnosis (PGD) allowed Yes/No	Preimplan-tation genetic diagnosis reimbursed Yes/No	Assisted hatching allowed Yes/No	Assisted hatching reimbursed Yes /No	Sperm donation for in vitro fertilization (IVF) permitted Yes/No	Sperm donation for IVF reimbursed Yes /No	Oocyte donation permitted Yes/No	Oocyte donation reimbursed Yes /No	Embryo donation allowed Yes/No
					n		n	n	n	n	n
Czech Republic	Yes[49]	No[49]	Yes,[49] in law[65]	No[49] Yes[65]	Yes, in law[65]	No information	Yes, in law[65]	No information	Yes, in law[65]	No information	No information
Denmark	Yes[49] Allowed only for research protocols under law[65]	Yes[49]	Yes,[49] in law[65]	Yes[49, 65]	Yes, in law[65]	No information	Yes, in law[3, 65]	No information	Yes, in law[3, 65]	No information	Not allowed in law[3]
Estonia	Yes[49]	No[49]	Yes[49]	No[49]	No information	No information	No information	No information	No information	No information	No information
Finland	Yes[49, 65]	No[49]	Yes[49] Allowed in law[65]	Yes[49, 65]	Yes,[65] in law	No information	Yes, in law[3, 65]	No information	Yes, in law[3, 65]	No information	Allowed in law[3]
France	Yes,[49] in practice[65]	Yes[49]	Yes[49] Yes, in law and guidelines[65]	Yes[49, 65]	Yes, in law and guidelines[65]	No information	Yes, in law[3] and in guidelines[65]	No information	Yes, in law[3] and in guidelines[65]	No information	Allowed in law[3]

Country	In vitro maturation (IVM) allowed Yes/No	In vitro maturation reimbursed Yes/No	Preimplan-tation genetic diagnosis (PGD) allowed Yes/No	Preimplan-tation genetic diagnosis reimbursed Yes/No	Assisted hatching allowed Yes/No	Assisted hatching reimbursed Yes /No	Sperm donation for in vitro fertilization (IVF) permitted Yes/No	Sperm donation for IVF reimbursed Yes /No	Oocyte donation permitted Yes/No	Oocyte donation reimbursed Yes /No	Embryo donation allowed Yes/No
Germany	Yes[49]	No[49]	No[49]	Not applicable[49]	No information	No information	Yes, in law[3]	No information	No[3]	Not applicable	Not allowed in law[3]
Greece	Yes[49]	No[49]	Yes[49] Allowed in law[65]	Yes[49, 65]	Yes,[65] in law	No information	Yes, in law[3, 65]	No information	Yes, in law[3, 65]	No information	Allowed in law[3]
Hungary	No[49]	Not applicable[49]	Yes[49]	No[49] Yes[65]	Yes,[65] in law	No information	Yes, in law[65]	No information	Yes, in law[65]	No information	No information
Iceland	Not specified[65]	No information	Not specified[65]	No information	Not specified[65]	No information	Yes, in law[65]	No information	Yes, in law[65]	No information	No information
Israel	Yes, in guidelines[65]	No information	Yes, in law and guidelines[65]	Yes[65]	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[65]	Funded in theory but not in practice[4]	Yes, in law and guidelines[65]	No[16]	No information
Italy	Yes,[49] in law[65]	No[49]	Yes[49] Yes, in law and guidelines[65]	Yes[49, 65]	Yes, in law and guidelines[65]	No information	Not allowed in law[16, 65]	Not applicable	Not allowed in law[16, 65]	Not applicable	Not allowed in law[3]
Latvia	Yes[49]	No[49]	No[49]	Not applicable.	Yes, in law and	No information	Yes, in law and	No informatio	Yes, in law and	No informatio	No informatio

Country	In vitro maturation (IVM) allowed Yes/No	In vitro maturation reimbursed Yes/No	Preimplan-tation genetic diagnosis (PGD) allowed Yes/No	Preimplan-tation genetic diagnosis reimbursed Yes/No	Assisted hatching allowed Yes/No	Assisted hatching reimbursed Yes /No	Sperm donation for in vitro fertilization (IVF) permitted Yes/No	Sperm donation for IVF reimbursed Yes /No	Oocyte donation permitted Yes/No	Oocyte donation reimbursed Yes /No	Embryo donation allowed Yes/No
				[49] Yes[65]	guidelines[65]		guidelines[65]	n	guidelines[65]	n	n
Lithuania	Yes[49]	No[49]	No[49]	Not applicable[49]	No information	No information	No information	No information	No information	No information	No information
Luxembourg	Yes (but not practiced)[49]	No[49]	Yes[49]	No[49]	No information	No information	No information	No information	No information	No information	No information
Malta	Yes[49]	No[49]	No[49]	Not applicable[49]	No information	No information	No information	No information	No information	No information	No information
The Netherlands	Yes[49]	No[49]	Yes[49]	No[49]	Yes[16]	No information	Yes, in law[3]	No information	Yes, in law[3]	No information	Allowed in law[3]
New Zealand	Yes, in guidelines[65]	Yes (personal communication)	Yes, in law and guidelines[65]	Yes[65]	Yes, in law and guidelines[65]	Yes (personal communication)	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[65]	No information	No information
Norway	Yes, in law[65]	No information	Yes, in law and guidelines[6]	Yes[65]	Yes, in law and guidelines[6]	No information	Yes, in law and guidelines[6]	No information	Not allowed in law[16, 65]	Not applicable	Not allowed in law[16]

Country	In vitro maturation (IVM) allowed Yes/No	In vitro maturation reimbursed Yes/No	Preimplan-tation genetic diagnosis (PGD) allowed Yes/No	Preimplan-tation genetic diagnosis reimbursed Yes/No	Assisted hatching allowed Yes/No	Assisted hatching reimbursed Yes /No	Sperm donation for in vitro fertilization (IVF) permitted Yes/No	Sperm donation for IVF reimbursed Yes /No	Oocyte donation permitted Yes/No	Oocyte donation reimbursed Yes /No	Embryo donation allowed Yes/No
			[5]		[5]		[5]				
Poland	Yes[49]	No[49]	Yes[49]	No[49]	No information	No information	No information	No information	No information	No information	No information
Portugal	Yes[49]	No[49]	Yes[49]	No[49]	No information	No information	Yes, in law[3]	No information	Yes, in law[3]	No information	Allowed in law[3]
Romania	Yes[49]	No[49]	Yes[49]	No[49]	No information	No information	No information	No information	No information	No information	No information
Russia	Yes, in guidelines[65]	No information	Yes in law and guidelines[65]	Yes[65]	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[65]	No information	No information
Slovakia	Yes[49]	No[49]	Yes[49]	No[49]	Yes,[65] in law	No information	No information	No information	No information	No information	No information
Slovenia	Yes,[49] in law[65]	Yes[49]	Yes,[49] allowed in law[65]	Yes[49, 65]	No information	No information	Yes, in law[65]	No information	Yes, in law[65]	No information	No information
Spain	Yes[49]	No[49]	Yes[49] Yes in law	Yes[49, 65]	Yes, in law and	No information	Yes, in law[3, 65]	No informatio	Yes, in law[3, 65]	No informatio	Allowed in law[3]

Country	In vitro maturation (IVM) allowed Yes/No	In vitro maturation reimbursed Yes/No	Preimplan-tation genetic diagnosis (PGD) allowed Yes/No	Preimplan-tation genetic diagnosis reimbursed Yes/No	Assisted hatching allowed Yes/No	Assisted hatching reimbursed Yes /No	Sperm donation for in vitro fertilization (IVF) permitted Yes/No	Sperm donation for IVF reimbursed Yes /No	Oocyte donation permitted Yes/No	Oocyte donation reimbursed Yes /No	Embryo donation allowed Yes/No
			and guidelines[65]		guidelines[65]			n		n	
Sweden	Yes,[49] in guidelines[65]	Yes[49]	Yes[49] Yes, in law and guidelines[65]	Yes[49, 65]	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[5, 3]	No information	Not allowed in law[3]
Switzerland	Yes[65]	No information	No, in law and guidelines[65]	No[65]	Yes, in law and guidelines[65]	No information	Yes, in law and guidelines[65]	No information	Not allowed in law[65]	Not applicable	No information
Turkey	No information	No information	No information	No information	No information	No information	Not allowed in law[65]	Not applicable	Not allowed in law[65]	Not applicable	No information
UK	Yes,[49] in guidelines[65]	Yes[49]	Allowed in law[65]	Yes[65]	No information	No information	Yes, in law[3, 65]	No information	Yes, in law[3, 65]	No information	Allowed in law[3]

Table 7 presents the proportion of the costs associated with **intrauterine insemination**, **in vitro fertilization** and **intracytoplasmic sperm injection** treatments paid out of public funds, where the information was available.

Nineteen countries (Australia, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, the Netherlands, New Zealand, Portugal, Slovakia, Slovenia, Sweden and UK England) provide full or partial funding for **intrauterine insemination** through their national health plans. Three countries (Austria, Bulgaria and Israel) do not fund intrauterine insemination through their national health plans. It is not clear whether or not Latvia and Poland provide public funding for intrauterine insemination.

Twenty-three countries (Australia, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, Italy, Latvia, the Netherlands, New Zealand, Norway, Portugal, Slovakia, Slovenia, Sweden and UK England) fund or partially fund **in vitro fertilization** or **intracytoplasmic sperm injection** through their national health plans.

With respect to how public funding is used for individual aspects (investigation, medication, laboratory or medical expertise) of **intrauterine insemination**, **in vitro fertilization** or **intracytoplasmic sperm injection**, no two countries are the same.

Table 7 Proportion of reimbursements through public funding for intracytoplasmic sperm injection (ICSI) or in vitro fertilization (IVF) and intrauterine insemination (IUI), by country, 2009–2015

Unless otherwise indicated by a reference number in the cell, all information in this table has been taken from the sources cited for each country in the first column

	ICSI/IVF						IUI				
	Laboratory	Clinical					Laboratory	Clinical			
Country		Agonist/antagonist drug	Gonadotrophic drug	Medical consultation	Blood	Echography		Gonadotrophic drug	Medical consultation	Blood	Echography
	%	%	%	%	%	%	%	%	%	%	%
Austria[49]	70	70	70	100	100	100	0	0	0	0	0
Belgium[49]	100	95	95	95	95	95	100	95	95	95	95
Bulgaria[49]	Covered since 2009.[1]	Covered.[1]	Covered.[1]	Covered since 2009.[1]	Covered since 2009.[1]	Covered since 2009.[1]	0	0	0	0	0
Canada (Ontario)[70]	Covered	Drugs not covered	Drugs not covered	Covered	Covered	Covered	Covered	Drugs not covered	Covered	Covered	Covered
Cyprus[49]	Not specified	0	Not specified	0	0	0	0	0	0	0	0
Czech Republic[49]	100	100	100	100	100	100	100	100	100	100	100
Denmark (public clinic)[49]	100 up to 2010. Since	75 up to 2010. Cost-sharing for drugs.[3]	75 up to 2010. Cost-sharing	100 up to 2010.	100 up to 2010.	100 up to 2010.	Not specified	75	75	100	100

	ICSI/IVF						IUI				
	Laboratory	Clinical					Laboratory	Clinical			
Country		Agonist/antagonist drug	Gonadotrophic drug	Medical consultation	Blood	Echography		Gonadotrophic drug	Medical consultation	Blood	Echography
	2010, a contribution of €1,840.[12]		for drugs.[3]								
Estonia[49]	100	90	90	100	100	100	0	10	100	100	100
Finland[49] Between 60% and 75% of infertility and IVF treatment costs covered by the National Pension Institute.[72]	75	42–100. Cost-sharing for drugs.[3]	42–100. Cost-sharing for drugs.[3]	60	75	75	75	42–100	60	75	75
France[49]	100	100	100	100	100	100	Not specified	Not specified	Not specified	Not specified	Not specified

	ICSI/IVF						IUI				
	Laboratory	Clinical					Laboratory	Clinical			
Country		Agonist/antagonist drug	Gonadotrophic drug	Medical consultation	Blood	Echography		Gonadotrophic drug	Medical consultation	Blood	Echography
Germany[49]	Not specified	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]	Not specified	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]	50 75% in those states that have ratified the 2012 law.[71]
Greece[49]	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Hungary[49]	100	Not specified	70	100	100	100	100	30	100	100	100
Ireland[49, 62]	20 tax credit Provided you or your partner pay tax.[62]	Drug costs can be claimed under the HSE High Tech Scheme.[62]	After the first €144, drug costs can be claimed under the HSE High Tech	20 tax credit	20 tax credit	20 tax credit	20 tax credit	After the first €144, drug costs can be claimed under the HSE High Tech	20 tax credit	20 tax credit	20 tax credit

	ICSI/IVF						IUI				
	Laboratory	Clinical					Laboratory	Clinical			
Country		Agonist/antagonist drug	Gonadotrophic drug	Medical consultation	Blood	Echography		Gonadotrophic drug	Medical consultation	Blood	Echography
			Scheme.[62]					Scheme.[62]			
Israel[4] Overall US$100 user fee	Almost 100%	Almost 100%	Almost 100%	Almost 100%	Almost 100%	Almost 100%	Not promoted	Not promoted	Not promoted	Not promoted	Not promoted
Italy[49]	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Latvia[49]	Not specified	0	0	0	0	0	0	Not specified	Not specified	Not specified	Not specified
Lithuania[49]	0	0	0	0	0	0	0	0	0	0	0
Luxembourg[49]	100	100	80	100	100	100	0	80	100	100	100
Malta	0	0	0	0	0	0	0	0	0	0	0
The Netherlands[49] Public funding changed in	100	100	100	100	100	100	Not specified	0	0	0	0

	ICSI/IVF						IUI				
	Laboratory	Clinical					Laboratory	Clinical			
Country		Agonist/antagonist drug	Gonadotrophic drug	Medical consultation	Blood	Echography		Gonadotrophic drug	Medical consultation	Blood	Echography
2013											
New Zealand	100	100	100	100	100	100	100	100	100	100	100
Poland[49]	0	0	0	0	0	0	Not specified	Not specified	Not specified	Not specified	Not specified
Portugal[49]	Not specified	69 Cost-sharing for drugs.[3]	69 Cost-sharing for drugs.[3]	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Romania[49]	0	0	0	0	0	0	0	0	0	0	0
Slovakia[49]	75	75	75	100	100	100	0	0	0	0	0
Slovenia[49]	100	100	100	100	100	100	100	100	100	100	100
Spain (public clinic)[49]	Not specified. Partial.[16]	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Sweden (public clinic) [49]	100	100	100	100	100	100	Not specified	100	100	100	100
UK England (public clinic)[49]	100	100 If you are eligible for NHS-funded	100 If you are eligible for	100	100	100	Not specified	100 If you are eligible for	100	100	100

	ICSI/IVF						IUI				
	Laboratory	Clinical					Laboratory	Clinical			
Country		Agonist/antagonist drug	Gonadotrophic drug	Medical consultation	Blood	Echography		Gonadotrophic drug	Medical consultation	Blood	Echography
		IVF treatment, you will still have to pay prescription charges for fertility medicines, unless you are exempt from prescription charges.[78]	NHS-funded IVF treatment, you will still have to pay prescription charges for fertility medicines, unless you are exempt from prescription charges.[78]					NHS-funded IUI treatment, you will still have to pay prescription charges for fertility medicines, unless you are exempt from prescription charges.[78]			

5.1.5 Assisted reproductive technologies: cycles

The number of cycles funded through the public health service varies, from one cycle in Ukraine to a limitless number of cycles in four countries (Australia, Czech Republic, Estonia and Israel). The bulleted list presents a summary of the number of cycles allowed in each country:

- No limit on the number of cycles: Australia, Czech Republic, Estonia and Israel
- Limit between four and six cycles: Austria, Belgium, Croatia, France, Hungary, Luxembourg and Slovenia
- Limit of three cycles: Bulgaria, Denmark, Finland, Germany, the Netherlands, Norway, Portugal, Spain, Sweden and the UK (NICE)
- Limit of two cycles: New Zealand, Scotland (three in near future), Serbia and Montenegro, and Slovakia
- Limit of one cycle: Ukraine
- Limits vary by geography or funder directives: Finland (one to three cycles), Greece, Italy, Sweden, England and Wales (nil to three cycles)
- No information: Russia
- Publicly funded service not available: Cyprus (Ministry of Finance funding and limited to one procedure); Ireland (private health insurance and tax rebate); Lithuania; Malta; Poland (funding ceased June 2016); Romania (pilot programme); and Switzerland (Table 8).

The number of cycles that each health system is allowed to fund using public monies appears to be related to the priority placed on infertility as a problem and, separately, the other health priorities competing for the same funding.

Table 8 Number of cycles and number of embryos transferred under public funding criteria for assisted reproductive technologies, by country, 2009–2015

Country	Number of cycles allowed	Same criteria for public and private centres
Australia	No limit.[16, 43]	No information
Austria	Maximum four.[3, 16, 67] However, if a pregnancy is achieved with four cycles, the woman may be considered for another four cycles.[67]	Yes[49]
Belgium	Maximum six.[3, 16, 67]	No[49]
Bulgaria	Since 2009, a woman can have up to three cycles.[1]	Yes[49]
Croatia	Maximum four intrauterine inseminations and six in vitro fertilizations.[67]	No information
Cyprus	Limited to one procedure.	No public service
Czech Republic	No limit.[49]	Yes[49]
Denmark	Three cycles.[3, 16, 67] But may allow more if there are frozen embryos from the woman.[67]	No[49]
Estonia	No limit.[49]	Yes[49]
Finland	Maximum three. There are further limits on number of cycles allowed, but the limit varies by regional authorities and geographical areas.[3, 16]	No information
France	Maximum four.[3, 16] However, if a live birth is achieved, same treatment options available for a further pregnancy.[3, 72]	Yes[49]
Germany	Maximum four.[72] Currently, three cycles.[3, 16, 79]	Yes[49]
Greece	Varies,[3] decided by social security fund (healthcare cover). Maximum four IVF treatment cycles.[67]	Yes[49]
Hungary	Maximum five.[67]	Yes[49]
Israel	In vitro fertilization costs are (almost) fully subsidized up to the birth of two children for all Israelis.[16] The user pays US$100 per cycle.	No information
Italy	There are limits to the number of cycles allowed, but the limit varies by regional authorities and geographical areas.[3, 16]	No[49]
Latvia	Not applicable.[49] No new information.	No information
Lithuania	Not applicable.[49]	No criteria as only private centres exist.[49]
Luxembourg	Four cycles maximum.	Yes[49]
Malta	Not applicable.[49]	No public service[49]

Country	Number of cycles allowed	Same criteria for public and private centres
The Netherlands	Three cycles.[3, 16]	There are no private centres; only public centres exist.[49]
New Zealand	Up to two cycles of in vitro fertilization or intracytoplasmic sperm injection.[16] One cycle of in vitro fertilization or intracytoplasmic sperm injection with preimplantation genetic diagnosis. Up to four cycles of intrauterine insemination.[18, 73] For couples who meet the criteria, two cycles of IVF are fully funded. For women with unexplained infertility it is slightly different, as they can choose two cycles of IVF, or eight cycles of IUI, or one cycle of IVF and four cycles of IUI. Women who meet the criteria but do not start a cycle until age 40 will only get one cycle of IVF. (C Farquhar, Personal communication, 2016)	No information
Norway	Maximum three cycles.[67]	
Poland	Not applicable.[49]	No service at the time.[49]
Portugal	In private clinic, this varies, and is decided by doctors.[3] National health service criteria:[35] • up to three sessions of intrauterine insemination • up to three attempts at in vitro fertilization or intracytoplasmic sperm injection. Limits are justified by inadequate resources and long waiting times.	No[49]
Romania	Not applicable[49]	No service at the time.[49]
Russia	No information	No information
Serbia and Montenegro	Maximum two cycles.[67]	No information
Slovakia	Maximum two cycles.[67]	No criteria at that time.[49]
Slovenia	Maximum four cycles.[67]	Yes[49]
Spain	Maximum three IVF cycles, by law.[3, 16]	Yes[49]
Sweden	Varies[3] from one to three cycles, depending on regions.[3,72] Maximum three cycles.[16]	Yes[49]
Switzerland	No public funding	No public

Country	Number of cycles allowed	Same criteria for public and private centres funding
Ukraine	Maximum one cycle.[67]	No information
UK England	NICE recommends a maximum of three fresh cycles.[80] Varies;[3] decided by local commissioners.[78] Of the CCGs offering IVF to patients, 125 CCGs fund one cycle of treatment. 46 CCGs fund two cycles of treatment and only 34 CCGs fund three cycles. 4 CCGs do not fund any treatment whatsoever.[75]	There are private centres but they do not receive public (NHS) funding.[49]
UK Scotland	Agreed national criteria since 2013. Two cycles; must go to end of waiting list after unsuccessful cycle.[75, 81] Cannot have NHS-funded cycles if they have already been given them elsewhere in the UK.[75, 81] The 2016 report recommends that eligible patients may be offered up to three cycles of in vitro fertilization or intracytoplasmic sperm injection where there is a reasonable expectation of a live birth.[76] No individual (male or female) can access more than the number of NHS-funded in vitro fertilization treatment cycles supported by NHS Scotland under any circumstances, even if they are in a new relationship.[75, 81]	No information
UK Wales	Provision in Wales is set by the Welsh Health Specialised Services Committee, the body responsible for commissioning all specialist tertiary NHS services in Wales. Since 2010, Wales has offered women under 40, two rounds of in vitro fertilization/intracytoplasmic sperm injection treatment. Women aged between 40 and 42 years who meet the access criteria are entitled to one cycle of in vitro fertilization/intracytoplasmic sperm injection .[75] Previous cycles, whether NHS or privately funded, are taken into account and determine the level of treatment offered.[75]	No information

5.1.6 Assisted reproductive technologies: public or private treatment clinic

Ten countries (Australia, Austria, Czech Republic, Estonia, France, Germany, Greece Hungary, Italy and Latvia) fund public patients needing assisted reproductive technologies in a network of private clinics and do not appear to have any public clinics (Table 9). Since 2010, user fees in Australia have increased by between 300% and 400% as a result of a cap on the rebate to users, in an attempt to control charges by medical specialists who seemed to increase their fees to absorb 78% (on average) of the increases in Australian Government spending.[43, 9] Only 22% of increases went to defraying the patients' out-of-pocket expenses.[43] The government introduced the cap to create a more sustainable approach to funding.

Six countries (Luxembourg, the Netherlands, Slovenia, Spain, Sweden and UK England) fund public patients needing assisted reproductive technologies in public clinics only. England and Sweden[71, 72] have long waiting lists.

Another four countries (Finland [64% private], New Zealand [75% private], Norway [33% private] and Portugal) fund public patients needing assisted reproductive technologies in a mix of public and private clinics.

Ten countries (Belgium, Bulgaria, Croatia, Denmark, Israel, Italy, Latvia, Russia, Scotland and Wales) do not specify whether patients are treated in public or private clinics. Scotland has reduced its waiting lists.[76]

Accreditation is used in some countries (Australia, England and Scotland) to ensure that all clinics offering assisted reproductive technologies provide high-quality treatment.

Table 9 Number of public and private centres being given public healthcare funds to provide assisted reproductive technologies, by country, 2009–2015

Country	Public and private centre numbers and public funding
Australia	Treatment primarily offered through private clinics.[7] In 2012,[9] there were 68 such clinics. Centres must be accredited.[82]
Austria	25 centres in 2013.[65] Austria funds private clinics to treat publicly funded patients.
Belgium	31 centres in 2013.[65]
Bulgaria	23 centres in 2013.[65]
Croatia	13 centres in 2013.[65]
Cyprus	No service.
Czech Republic	38 centres in 2013.[65] Czech Republic funds private clinics to treat publicly funded patients.
Denmark	18 centres in 2004 (50% public and 50% private);[40] 18–21 centres in 2013.[65] In 2008, patients had to attend a public clinic in order to receive publicly funded services.[49] It is not clear if public funds are used to pay for treatment in private centres.
Estonia	Estonia funds private clinics to treat publicly funded patients.[49]
Finland	14 centres in 2004 (36% public and 64% private);[40] increased to 18 centres in 2013.[65] 60% of all in vitro fertilization treatments are provided by private services,[27] and the national health insurance fund pays 60% of the doctor's fee; part of the costs of the investigations, and 50% of the medications, are paid for by the Social Insurance Institution of Finland.[27] Overall, patients attending private centres pay 50% of total costs and public patients pay 24% of total costs.[27]
France	100 centres in 2013.[65] France funds private clinics to treat publicly funded patients.
Germany	Germany funds private clinics to treat publicly funded patients.[49]
Greece	Approximately 60 centres in 2013.[65] Greece funds private clinics to treat publicly funded patients.
Hungary	14 centres in 2013.[65] Hungary funds private clinics to treat publicly funded patients.
Israel	24 in the mid-1990s;[1] 29 centres in 2013.[65]
Italy	350 centres in 2013.[65] Italy funds private clinics to treat publicly funded patients.[49]
Latvia	Four centres in 2013.[65] Latvia funds private clinics to treat publicly funded patients.[49]
Lithuania	Private centres exist.[49] No public funding.
Luxembourg	There are no private centres; only public centres exist.[49]
Malta	No public service.[49]
The Netherlands	There are no private centres; only public centres exist.[49]
New Zealand	Seven centres in 2013;[65] eight centres, of which two are public

Country	Public and private centre numbers and public funding
	and six are private, in 2014.[77] Most fertility services providers are in the private sector. There are two district health board providers – in Auckland and Dunedin.[77] Public funding is used to pay for assisted reproductive treatment in private centres for those who meet the eligibility criteria.
Norway	Six public and three private centres in 2004;[40] 10 centres in 2013.[65] Public funding available for fertility treatment but only in public hospitals/clinics.[65]
Poland	The state ran an in vitro fertilization programme, which was expected to end halfway through 2016.[63]
Portugal	28 centres in 2013.[65] Mix of private and public clinics providing publicly funded service.[35]
Romania	No public service.[49] Ministry of Health set up a pilot programme in 2011.
Russia	110–130 centres in 2013.[65] Status with respect to whether or not public funding is used to pay for assisted reproductive technologies in private centres is unclear.
Slovakia	No criteria for funding.[49]
Slovenia	Only public centres;[49] three centres in 2013.[65]
Spain	All centres are public centres[49] and there were over 100 centres in 2013.[65]
Sweden	There are no private centres providing public treatment.[49] Four public centres and six private centres in 2004.[40] 16 centres in 2013.[65]
Switzerland	26 private centres in 2013.[65] No public funding.
United Kingdom (UK)	71–117 centres in 2013.[65] The situation with respect to public funding of assisted reproductive technologies in private centres differs in the three jurisdictions of the UK.[65]
UK England	There are private centres but they do not receive public (NHS) funding.[49]
UK Scotland	All centres require a licence from the Human Fertilisation and Embryology Authority. Women can use private funds to access in vitro fertilization in NHS centres,[65] but it is not clear if women can be funded by the NHS to use private centres.
UK Wales	No information

5.1.7 Source of national healthcare funding and policy context

Each country has its own unique method of funding public health services and funding assisted reproductive technologies. These data are presented in Table 10. The interaction beween public health funding bodies and third-party private insurance companies with respect to assisted reproductive technologies was not investigated in any of the literature retrieved. We present relevant data, where available, in Appendix 8.

Table 10 National healthcare funding and assisted reproductive technology funding sources, by country, 2009–2015

	National healthcare funding and assisted reproductive technology funding sources
Australia	National health plan and private insurance.[8, 65] Medicare payments were capped for each treatment type in 2010 and user out-of-pocket fees increased by between 300% and 400% rising from a 20% out-of-pocket payment to a 70% payment. This was done to control medical inflation and make funding more sustainable.
Austria	National health plan,[65, 66] which funds about 66% of approved assisted reproductive technology treatments.
Belgium	National health plan (Belgian Health Insurance) and standard third-party private insurance.[65, 66] Public funding covers 95% of assisted reproductive treatments.
Bulgaria	National health plan.[65, 66] Since 2009, a woman can be paid up to BGN5,000 (approximately €2,500), which will cover one in vitro fertilization cycle, including both the medications and the procedure itself. If the total value is over BGN5,000, the difference will be covered by the patient. The money will be kept in a special fund controlled by government administration, patient organizations and in vitro fertilization specialists.[1]
Canada (Ontario)	Federal government raises funds through payroll deductions (a healthcare tax). The provincial ministry of health issues a health card to each individual who enrols in the programme and this entitles the person to a standard level of care, including fertility treatments.[83] Since December 2015, approved assisted reproductive technologies have not been covered although healthcare tax/insurance and the provincial government now funds clinics directly to provide these treatments.[70]
Denmark	National health plan[65, 66] is funded through local taxes. In 2004, there were no user fees.[40] Currently, user fees are imposed; these were increased by 500% in 2010 for in vitro fertilization.[12] Under the increased user fees, a cycle of in vitro fertilization costs €1,840 in out-of-pocket payments.
Finland	National health plan[65, 66] is funded through tax and a national insurance system. There are user fees for public clinics. In 2004, the user fee was €22.[40] Currently, patients attending private centres pay 50% of total costs and public patients pay 24% of total costs.[27]
France	National health plan[65, 66] is financed by government through a system of national

	National healthcare funding and assisted reproductive technology funding sources
	health insurance. The presence of user fees are not referred to in the literature.
Germany	National health plans are funded through the national social health insurance system. There have been user fees since 2004. Between 2004 and 2012, patients paid 50% of the costs of assisted reproductive technologies; on 2 March 2012, the Federal Council approved a draft law under which the federal government provides a subsidy of 25% towards the costs of assisted reproductive technologies. Thus, the share of costs borne by a couple drops to just 25% in the states that have sanctioned the federal law.[71] Six of the 16 states have implemented the programme that permits the 75% subsidy.[67]
Greece	National health plan[65, 66] is funded through social insurance (appears to be optional). No mention of user fees.
Hungary	National health plan,[65, 66] which requires patients to pay either 30% or 70% of gonadotrophic drugs.
Israel	National health plan.[37, 65, 66] Reproductive technologies are subsidized as a standard part of the basic basket of health services by the Israeli National Health Insurance. A modest user fee of circa US$100.[4] In vitro fertilization treatments accounted for 1.8% of the national health budget in 2005.[4]
Italy	National health plan;[65, 66] a tax-based public funding scheme. There are user fees.
Japan	Japan has universal coverage for health insurance and medical co-payments are usually 30%. Artificial reproduction procedures are not covered and were done at a patient's own expense until 2004, when the government introduced a means-tested subsidy. Only couples whose annual household income is lower than ¥7,300,000 (about US$83,000) are eligible for the subsidy. Until March 2013, up to ¥150,000 was provided per cycle of autologous in vitro fertilization (50% of cost), intracytoplasmic sperm injection or frozen embryo replacement. Since April 2013, the upper limit of the subsidy for frozen embryo replacement or failed oocyte retrieval has been reduced to ¥75,000, but the other subsidies remain unchanged. Assisted reproductive technologies are provided for up to two cycles annually for five years, and up to 10 times in total. There are no other eligibility criteria, such as the woman's age or causes of infertility, to access the subsidy.[28]
The Netherlands	All primary and curative care (i.e. the family doctor service and hospitals and clinics) is financed from private compulsory health insurance. Most private 'compulsory' insurance companies also pay for three in vitro fertilization cycles[72] but charge a co-payment. There were some changes to coverage in 2013.
New Zealand	National health plan.[65, 66] The service excludes people who do not meet the access threshold for publicly funded assisted reproductive technology treatment.[73] Public funding depends on geographic location. In some areas, drugs are funded, and in others, co-payment is required.[72] The numbers of the population who can access the service is dependent on regional health funding and there are waiting lists.[72] Waiting lists vary from 6–18 months depending on the District Health Board of residence. Individuals using private services are generally not covered under personal health insurance policies and have to pay from their own pockets.[72] Full cover is provided if people meet eligibility criteria.[65] No co-payment will be sought from service users for any service covered by the assisted reproductive technology

	National healthcare funding and assisted reproductive technology funding sources
	service specification, including supplies and equipment, other than service users who receive services for embryo storage after 18 months of first storage for infertility, and 10 years for service users using fertility preservation.[73] Embryo transfers for purposes of gestational surrogacy are not covered.[71]
Norway	National health plan[65, 66] is funded through local taxes. In 2004, the user fee in a public clinic for an assisted reproductive technology cycle was between €190 and €256.[40] Currently, patients pay up to €2,500 (19,000 Norwegian Krone) for up to three treatment cycles at governmental units.[65]
Portugal	National health plan[65, 66] is funded by tax. 69% of drug costs are covered. It is not clear if any other costs are covered. No private health insurance cover.[35]
Slovakia	Mandatory private health insurance with user co-payments for hospital services and pharmaceutical services. Some funded services have user limits set.[83]
Slovenia	National health plan[65, 66] is financed through a compulsory social healthcare fund. There do not appear to be any user fees.
Spain	National health plan and private health insurance.[65, 66] Overall funding full[65, 66] up to the age of 40,[66] and partial funding thereafter.
Sweden	National health plan[65, 66] is funded through local taxes. There are user fees. In 2004 there were no user fees for assisted reproductive technologies.[40]
UK overall	National health plan[65] is funded by central UK government.[83]
UK England	National health plan[65] is a tax-based public funding scheme. Working adults pay a user fee for prescriptions, dentistry and ophthalmology. In theory, women of a certain age have a right to assisted reproductive technologies but this policy is often modified by local clinical commissioning groups, in breach of the *NHS Constitution for England*, which provides that patients have the right to drugs and treatments that have been recommended by NICE for use in the NHS.[75] It is not clear how this applies to assisted reproductive technologies.
UK Scotland	National health plan[65] is a tax-based public funding scheme. There are no user fees. The funding made available for the NHS in Scotland comes from the public money given to Scotland by the UK Government. The following services are fully funded: funding for hospital and community health services, general practitioner visits, prescribing, pharmaceutical services and primary care services.[83] It is not clear how this applies to assisted reproductive technologies.

5.1.8 Summary: Question 1

Question 1
The literature reports that there are three public funding mechanisms applied in publicly funded healthcare for assisted reproductive technologies. The first is 'full', which is defined by the European Society of Human Reproduction and Embryology (ESHRE) as 81% or more for at least one cycle. The second is 'partial', which is defined by ESHRE as as between 1% and 80% for at least one cycle and the third is a policy of no funding from the public health system.

Full public funding (using the ESHRE definition) with a small out-of-pocket contribution paid by patients in some of the countries is provided in the UK (no out-of-pocket charge, but regional variations in access), Belgium, France, Israel, New Zealand (no out-of-pocket charge), Ontario, Slovakia, Slovenia and Spain (only available to women aged <40 years).

Partial public funding (using the ESHRE definition) means that a significant out-of-pocket contribution paid by the patient is provided in Australia, Austria, Denmark, Finland, Germany, Greece, Iceland, Italy, the Netherlands, Norway, Portugal and Sweden (but regional variations in access). There is a wide variation in the patient contribution between countries, with the lowest contribution at around 30% of the cost of a cycle and the highest contribution at 70% of a cycle cost.

Cyprus, Japan, Ireland, Lithuania, Malta, Romania, Switzerland, and the US do not, in theory, fund assisted reproductive technologies. However, some countries with no public funding have other mechanisms to help pay for treatment, such as a tax rebate (Ireland, and Manitoba), a publicly funded high-tech drug scheme for all citizens who spend over a certain monthly limit (Ireland), a means-tested subsidy (in Japan), or mandated private health insurance to cover or offer coverage (in 15 states of the USA.)

Since 2008, the number of countries providing public funding for assisted reproductive technologies has increased, but individual countries' public funding has decreased and out-of-pocket payments have increased.

The most common basket of services provided through publicly funded assisted reproductive technologies is intrauterine insemination, in vitro fertilization, intracytoplasmic sperm injection and preimplantation genetic diagnosis. There is no documentary evidence that assisted hatching and sperm or oocyte donation for in vitro fertilization are funded or partially funded by public health services.

The number of cycles funded through the public health service varies, from one cycle in Ukraine to a limitless number of cycles in four countries (Australia, Czech Republic, Estonia and Israel).

Ten countries (Australia, Austria, Czech Republic, Estonia, France, Germany, Greece Hungary, Italy and Latvia) fund public patients needing assisted reproductive technologies in

a network of private clinics and do not appear to have any public clinics. Another four countries (Finland, New Zealand, Norway and Portugal) fund public patients needing assisted reproductive technologies in a mix of public and private clinics. Six countries (Luxembourg, the Netherlands, Slovenia, Spain, Sweden and UK England) fund public patients needing assisted reproductive technologies in public clinics only. England and Sweden have long waiting lists.

In six countries (Australia, Austria, Germany, Greece, Latvia and Spain), the patient must claim a reimbursement for assisted reproductive technologies from the national health plan, which implies that the patient may need to pay the provider from their own resources before the reimbursement is issued.

5.2 Question 2: What are the costs and benefits of public funding for assisted reproductive technology (ART) for the funder, provider and service user?

5.2.1 Introduction

A number of studies suggest that utilization of assisted reproductive technologies is partly determined by the amount of out-of-pocket expenses incurred by individuals or couples who are experiencing difficulties in conceiving.[8, 9, 84] Out-of-pocket payments for assisted reproductive technologies are determined by the level of private health insurance or public funding available to couples. Public funding throughout the world varies from almost full public funding in Belgium, France, Slovakia, Slovenia, Spain (for women <40 years) and Israel to no public funding in Malta, Switzerland and the USA. The overall financial cost of assisted reproductive technologies on national exchequers is 0.25% of the national health budget or less, even for those countries offering generous public support for the procedure.

5.2.2 Costs and benefits

5.2.2.1 Costs

The **direct costs** of assisted reproductive technologies can be divided into separate categories. These include physicians' consultations, nursing services, medication, ultrasound scanning, laboratory tests, the actual assisted reproductive technology procedures, hospital charges and administration charges. The assisted reproductive technology procedures include oocyte collection, anaesthesia, sperm preparation, in vitro fertilization, sperm injection, genetic testing, and embryo transfer.

There are also **indirect costs** such as the cost of treatment complications (e.g., ovarian hyper-stimulation, anxiety and depression, and ectopic pregnancy),[49, 57] patient travel costs and lost productivity. However, more significant are the costs associated with inappropriate use of assisted reproductive technologies for women would have been able to conceive a child naturally, increased costs of assisted reproductive therapies per live birth for women over 40 years due to much higher failure rates, and multiple births.

In 2010, in the Canadian province of Quebec, the government introduced universal coverage for in vitro fertilization. The treatment was widely available and had no upper age limit. Initially, the government earmarked Can$31.32 million for the programme, forecasting that costs would increase to Can$43 million in 2011 and 2012 and Can$47 in 2013. However, demand for assisted reproductive technology services exceeded anticipated numbers by 50% and the operating budget also exceeded forecasts, rising to Can$60 million, Can$61 million and Can$70 million for the three years.[84] Demand was 11 times what was initially planned (Can$43 million rather than Can$3.8 million). Some of this overspend was explained in that reimbursement terms and billing models were not in line with the original plans. In November 2015, the government ended the programme.

The cost to Quebec taxpayers ranged from Can$43,153 for a single baby born to a woman aged 40, and Can$103,994 for those aged 43 under the publicly funded in vitro fertilization programme (Table 11). For those aged 44, the mean cost of failed in vitro fertilization was Can$597,800 – no babies were born to this group. In contrast to this, in vitro fertilization treatment that resulted in a live newborn, for women younger than 35, cost Can$17,919 on average.[85]

Table 11 Outcomes of in vitro fertilization for women aged 40 years and older, Quebec, 2010–2012

	Age in years				
	40	41	42	43	44
Number of cycle starts	1049	1005	944	488	141
Number of egg retrievals	972	922	865	447	128
Number of embryo transfers	770	722	692	356	99
Number of live births	105	69	51	20	0
Live birth rate per cycle start	10%	6.90%	5.40%	4.10%	0%
Mean treatment cost per birth up to 43 years and overall cost age 44 years	Can$43,153	Can$62,290	Can$79,100	Can$103,994	Can$597,800
(costs excluding medications)					

Source: Ouhilal *et al.* (2015)[85]

Ouhilal *et al.* (2015) conclude that, for women over the age of 40 years, live birth rates are substantially less and less likely and the financial cost substantially more, and they suggest that age eligibility criteria should be considered by any government planning to introduce public funding.

The costs surrounding multiple births have been shown to be substantial.[13] The maternal and infant cost of a twin pregnancy can be three times that of a singleton pregnancy and the cost of caring for multiple-birth infants continues for many years. Healthcare and educational resources for low-birth-weight children can be greater than normal-weight children up to eight or nine years.[13] High user costs may exclude women with less disposable income from the service.[15, 27]

Figure 2 presents the direct cost of a fresh in vitro fertilization cycle before government or third-party subsidization in 2006/2007. Purchasing power parity and average 2006 inter-bank exchange rates were used to convert all currencies to 2006 US$. Costs include pharmaceuticals.[13]

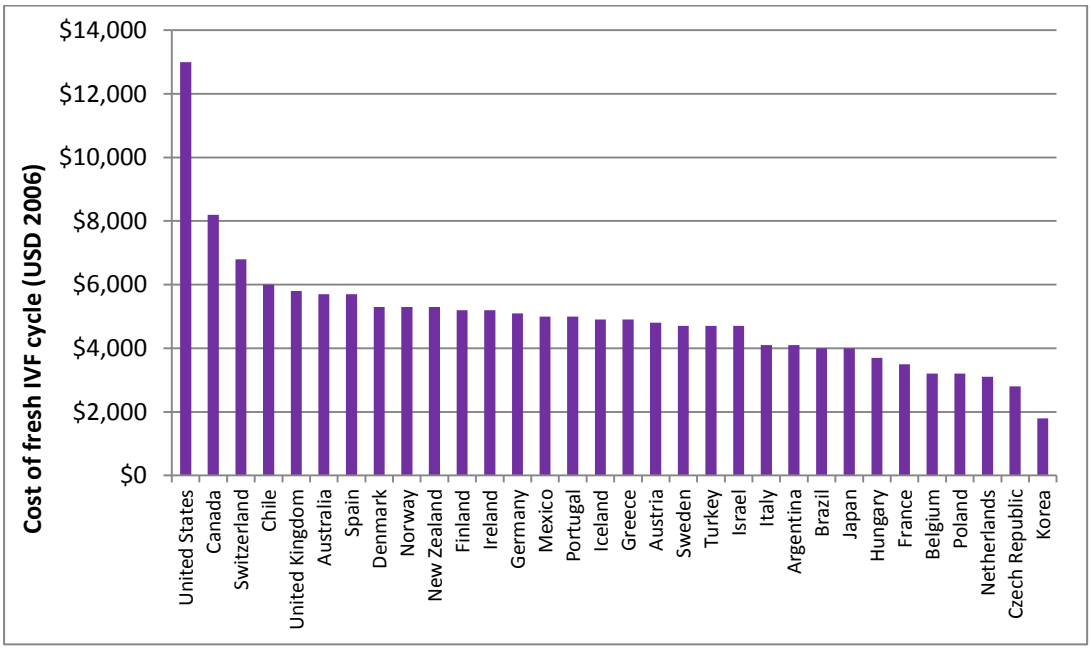

Figure 2 Direct cost (US$) of a fresh in vitro fertilization cycle before government or third-party subsidization in 2006/2007

***Source*: Chambers *et al*. (2013b)[13]**

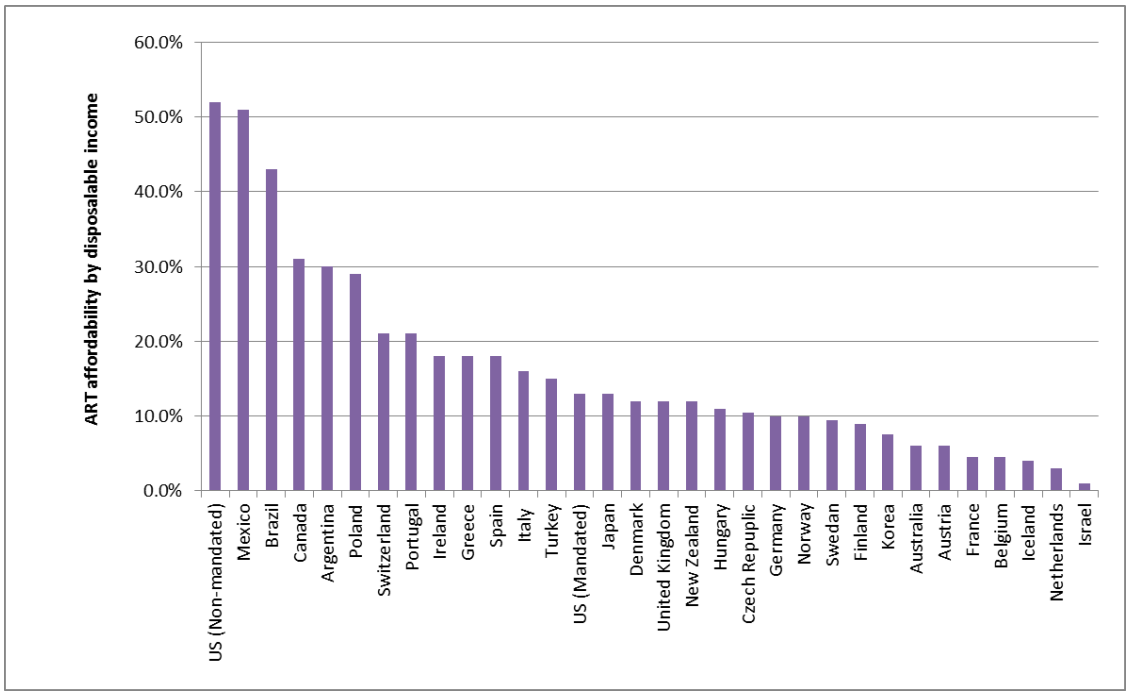

Figure 3 Affordability of ART based on net cost (US$) of a fresh in vitro fertilization cycle including government or third-party subsidization in 2006/2007

***Source*: Chambers *et al*. (2013b)[13]**

Assisted reproductive technology affordability is expressed as the net cost of a fresh in vitro fertilization cycle as a percentage of the annual disposable income of a single person earning 100% of average wages with no dependent children (Figure 3). Disposable income is calculated according to Organisation for Economic Co-operation and Development (OECD) methods. United States (mandated) denotes data from a sample of US states with comprehensive insurance mandates for assisted reproductive technology; United States (non-mandated) denotes data from US states with no fertility treatment mandates.[13] The impact of assisted reproductive technology is also related to the volume of treatments and services undertaken and how much of total healthcare expenditure it consumes. The total cost of all assisted reproductive technology treatments, including cancelled cycles and additional services, as a percentage of total public and private healthcare expenditure in 2003, is presented in Table 12. Together with this we also present the cost per live birth. The cost-effectiveness ratio is the relationship between the cost of the treatment and the success of the treatment. This is the cost per live birth in relation to the overall cost of assisted reproductive technology cycles. The cost per live birth was highest in the United States at US$41,132 per live birth, and lowest in Japan at US$24,329. The average cost per live birth for all countries combined was US$32,727.

Table 12 Cost of assisted reproductive technology treatments as a percentage of total public and private healthcare expenditure, selected countries, 2003

	Total assisted reproductive technology treatment costs as a percentage of total healthcare expenditure (US$ 2003)	Cost per live birth in 2003 for autologous assisted reproductive technology treatment cycles (US$ 2006)
United States	0.06%	$41,132
Canada	0.07%	$33,183
United Kingdom	0.13%	$40,364
Scandinavia	0.19%	$24,485
Japan	0.09%	$24,329
Australia	0.25%	$25,843

Source: Chambers *et al*. (2009)[7]

5.2.2.2 Benefits

The direct benefits of assisted reproductive technologies are the increased chance for single women and couples to become parents, particularly women aged under 40 years, and the increase in the young population of a country as a result of increased live births.

There are some economic projections, based on lifetime tax calculations (for 80 years), showing that the cost of children conceived through in vitro fertilization breaks even at around 40 years (compared with 38–39 years for naturally conceived children) and that funding of in vitro fertilization by the state represents good value for money (an indirect benefit).[10, 19, 45] Korea, Sweden and Estonia view assisted reproductive technologies as a method of redressing declining fertility rates.[10, 32]

Many countries view public funding for assisted reproductive technologies as a method of introducing safer embryo transfer practices and thereby reducing the incidence of multiple pregnancy and its associated complications. It is clear that providing a significant proportion of public funding will encourage women from lower socioeconomic groups to use this intervention, but, proportionally, women in the higher socioeconomic groups are more likely to use the service.[15, 27] The costs and benefits are explained more fully in the following sections.

5.2.3 Type of funding mechanism by economic equity (affordability and accessibility)

When seeking to design a system of public funding for assisted reproductive technologies there are three choices identified in the literature: no public funding, partial public funding with the balance paid ‘out-of-pocket’, and full (or almost full) public funding. Assuming that some form of public funding is to be considered, the choices are to pick a point between ‘no public funding’ and ‘full public funding’, which will assist the maximum number of patients and at the same time incentivize providers to use the safest and most cost-effective methods of treatment, benefiting both the service user and the state. Measuring the price

elasticity of demand may be a method to indicate the ideal combination of public funding and patient co-payment, to identify the most efficient mix of state and personal funding considering costs and benefits of assisted reproductive technologies.

Efficiency must be balanced with equity or equal access. The larger the out-of-pocket expense for the patient, the less likely they are to avail of assisted reproductive technologies.[2, 8, 9] For example, in the United States, where there is no public funding, the burden of payment falls on the patient or their private insurance company. The cost of a standard in vitro fertilization cycle represents 50% of an average United States citizen's disposable income.[7] Because of this cost, fertility clinics in the United States tend to transfer multiple embryos in order to maximize the potential for a live birth. This in turn can lead to multiple pregnancies.[2] The cost of assisted reproductive technology-associated multiple pregnancies in the USA is estimated at US$1 billion annually.[2] Where public funding is provided, policy-makers are better placed to influence clinical practice and reduce personal risk-taking by promoting or encouraging single-embryo transfer.[17] Since the 1980s, 15 states within the USA have passed laws that require private health insurers to either cover or offer coverage for infertility diagnosis and treatment.[64] Studies have demonstrated that in states with mandates versus those without mandates treatment practices can vary. It appears as if the state-level infertility insurance mandates have been a success. Schmidt has found that the mandates significantly increase first birth rates among white women aged 35 years and older.[86]

5.2.4 Affordability: out-of-pocket expense

Assisted reproductive technologies have evolved over the have evolved since the 1980s into a mainstream treatment for infertility. Up to five million children have been born worldwide following such therapies.[17] However, the utilization of assisted reproductive technologies varies substantially among countries, even where the prevalence of infertility is similar.[17] This reflects the differences in funding, regulation, cultural, social and religious norms in each country. For example, the Nordic countries perform 2.5 times the number of assisted reproductive technology cycles per woman of reproductive age reported in the USA, and single-embryo transfer is performed in 56% of fresh embryo treatment cycles compared with 13% in the USA. Lack of public funding in the USA prevents many couples receiving treatment and where they do go for treatment there is a financial imperative to transfer multiple embryos to enhance the chance of pregnancy. Chambers *et al.* [13] (2013b) measured affordability in terms of the net cost to patients of a fresh in vitro fertilization cycle after government or third-party subsidies, as a percentage of disposable income of a single person without dependants earning 100% of the average wage in their country (Figure 3). They further added variables such as access to clinics, the number of physicians per population, total fertility rate, economic development, gross national income per capita, proportion of GDP spent on healthcare and the proportion of healthcare spending involving out-of-pocket expense. The results suggest that the average cost that patients pay for treatment relative to their income (measured by the affordability variable) is significantly associated with not only who has access to treatment but also the way in which assisted reproductive technologies are practised. A 10% decrease in affordability predicted a 32% decrease in assisted reproductive technology utilization. There is also the suggestion that if

assisted reproductive technologies become too affordable, as in Quebec, younger women with a relatively high probability of natural conception may seek treatment, as will older women who have a low probability of treatment success.[17] The number of clinics per women of reproductive age was associated with assisted reproductive technology utilization, which suggests an element of supplier-induced demand. Affordability was also associated with the number of embryos transferred. Higher numbers of embryos were transferred in jurisdictions where assisted reproductive technologies were relatively more expensive, suggesting that the more expensive[17] the treatment the more likely it is that providers and users will employ less safe practices. Financial arrangements, be they public funding, third-party insurance or out-of-pocket funding, have a profound effect on the behaviour of clinicians and service users.

5.2.5 Elasticity of demand in developed economies

Price elasticity of demand is a measure of how much the quantity demanded of a good responds to a change in the price of that good, computed as the percentage change in quantity demanded divided by the percentage change in price.[87] All goods and services consumed, whether they are essential to life or a discretionary luxury, are sensitive to price change. Healthcare is no exception: as consumer prices increase, demand for services declines. Price elasticity of demand is inelastic when the percentage change in price leads to a smaller percentage change in quantity demanded; it is elastic when the percentage change in price leads to a larger percentage change in quantity demanded. Chambers *et al.*[7] (2009) estimated price elasticity of demand for assisted reproductive technologies in a number of developed economies: Australia, Scandinavia, Japan, the UK, Canada and the USA. Using the average consumer price of a standard fresh in vitro fertilization cycle, the results indicated that price elasticity of demand for assisted reproductive technologies in developed countries was relatively elastic in the mid-range prices, but relatively inelastic in the upper and lower price ranges. Where price elasticity of demand is elastic, a rise in price will lead to less consumption and a fall in price will lead to more consumption. The opposite is true when price elasticity of demand is inelastic. Healthcare is generally income elastic; therefore, as incomes rise, healthcare consumption rises more than proportionately.

In Germany in 2004, health authorities introduced a 50% co-payment for patients accessing assisted reproductive technologies in a cost-cutting exercise. Prior to this, the complete costs of assisted reproductive technologies, including the physician's fee and prescribed drugs, were reimbursed by the statutory health insurance funds.[88] The introduction of the 50% co-payment resulted in a large decrease in infertility treatments between 2004 and 2008. Those who could not afford to pay or part-pay for treatment went without, or discontinued treatment.

Price elasticity estimates are used by policy-makers and commercial analysts to predict how future price changes, in this case patient co-payments, are likely to influence demand for products and potential revenue consequences in the case of commercial organizations. Connolly *et al.* (2009b)[22] used the change in policy in Germany to examine the price elasticity of demand for assisted reproductive technology services. In the five years prior to the co-payment being introduced there had been a surge in demand. Their results suggest that

demand for treatment is relatively responsive to increases in co-payments. Similar results occurred when increases in co-payments for assisted reproductive technology services were introduced in Australia.[9] Policy-makers are interested in a public funding system which strikes a price that reduces unnecessary treatment, but increases effective and safe treatment. No one individual jurisdiction has come up with a perfect formula for this and good workable solutions are likely to come from trial and error over time.

However, Vaidya *et al*., working from Alberta, Canada, conducted a study to evaluate the cost-effectiveness and budget impact of providing assisted reproductive technologies in Alberta under three different policy scenarios in order to make comparisons with the status quo, which was no regulation or public funding. These were: a restrictive policy (Table 5.13) and a permissive policy (Table 5.13). The primary outcome was the cost per live birth of a healthy singleton. The modelling exercise demonstrated that publicly funded and scientifically regulated assisted reproductive technologies could provide treatment access and save healthcare expenditure. Cost-effectiveness for the three policy options was measured separately for three subgroups of women: <35, 35 to 39 and ≥40 years of age. The analysis focused on IVF in particular to the exclusion of other forms of assisted reproductive technology, because although it is the most effective treatment it is also the most expensive. The researchers used a Markov model and decision tree to compare various policy options in a variety of potential outcomes. The Markov model starts with patients who are subfertile to a point where there is a live birth. The decision tree then followed babies born up to their 18th birthday. The parameters used in the model were set by a number of experts in each area from treatment, through birth and on to adulthood.[89]

Table 13 **Competing policy options and corresponding restrictions on embryo transfer**

Current practice in Alberta (reference policy)	Funding under a restrictive policy	Funding under a permissive policy	Funding under Quebec's policy
No funding	<35 years of age: SET all cycles	<35 years of age: SET first cycle, DET second and third cycles	All women of childbearing age (no age limit) are eligible for funding. Women ≤36 years of age may receive SET or DET if the physician deems it necessary. Women > 36 years may receive a maximum of TET.
No restrictions	35 to 39 years of age: SET first two cycles, DET third cycle	35 to 39 years of age: DET first cycle, TET second and third cycles	
	≥40 years of age: DET first cycle, TET second and third cycles	≥40 years of age: TET all cycles	

Source: Vaidya *et al*. (2015)[89]

The costs of achieving a healthy singleton birth were between Can$91,000 and Can$268,000. The minimum costs accrued for a healthy singleton to 18 years was predicted to be Can$91,050 in the <35 years subgroup with the restrictive policy, Can$130,914 for the 35 to 39 years subgroup (restrictive policy) and Can$143,667 for the ≥40 years subgroup (restrictive policy). The restrictive policy was expected to lead to the smallest percentage of multiple births in the <35 years and 35 to 39 years subgroups, whereas the Quebec policy led to the smallest percentage of multiple births in the ≥40 years subgroup. The predicted cost, to the province, over time is set out in the Table 5.14.

Table 14 Costs (in millions of Canadian dollars) of multiples for subgroups with various policy options

Age Subgroups	no funding no regulation (status quo)	Restrictive	Permissive	Quebec
<35 years	42.45	5.75	32.17	1.25
35 to 39 years	29.08	11.13	45.87	18.13
≥40 years	14.45	16.62	11.07	7.28

Source: Vaidya *et al.* (2015)[89]

Cost-effectiveness in health economics is the ability to achieve an attainable treatment goal at the lowest possible cost. This study demonstrates that regulating the number of embryos transferred under a restrictive policy protocol could be a cost-effective policy for subfertile women aged up to 40 years.

5.2.6 Effects of limiting access to publicly funded assisted reproductive technologies

Allocation of scarce resources in a market economy is achieved by the price mechanism. Goods that are relatively scarce earn a higher price than those that are more abundant. In cases where the price mechanism is removed, such as state-sponsored free delivery of health services, demand rises and the price mechanism is replaced by waiting lists or large budget overruns. In Sweden and England, the national healthcare system has established limits on the number of in vitro fertilization cycles funded by the system. This has caused waiting lists for treatment which exacerbates the situation because of the impact of age on fecundity.[45]

5.2.7 Effect of out-of-pocket payments on access to assisted reproductive technologies by socioeconomic status

Assisted reproductive technology is expensive and in countries where in vitro fertilization is not supported by some form of public funding, its accessibility depends on a patient's ability

to pay. In France, where in vitro fertilization costs are almost fully covered by public resources, the use of in vitro fertilization did not differ according to women's socioeconomic position. In countries where the out-of-pocket contribution by the patient has increased to 50% of its cost, those on lower incomes are less able to afford the treatment and therefore do not access it. When dealing with fairness and equity an important question is how scarce healthcare resources can be allocated equitably with the maximum benefit to public health. Who should be favoured: those with 'greater need' but less chance of success or those with a better chance of success (younger women)?[27] Women in higher socioeconomic groups make greater use of assisted reproductive technology services in countries where this has been measured.[15, 27]

In Australia, up to 2010, Medicare allowed reimbursement of costs of assisted reproductive technology treatments, but with a co-payment of AU$1,500 for a fresh embryo transfer in vitro fertilisation cycle and AU$800 for a frozen embryo transfer in vitro fertilization cycle. In a policy change this out-of-pocket co-payment was increased to AU$2,500 and AU$1,000 respectively with similar increases for other assisted reproductive technology procedures. The number of assisted reproductive therapy cycles dropped sharply in 2010 but recovered by 2014.[90] Chambers *et al.*[15] divided women undergoing assisted reproductive technology into quintiles of socioeconomic status to examine how the changes in out-of-pocket payments affected the different groups. Quintile 1 was the lowest socioeconomic status and Quintile 5 was the highest. The women in the two higher socioeconomic status groups used fresh in vitro fertilization cycles more than the women in the lower groups before and after the policy change. Women in the highest group were twice as likely to use assisted reproductive technology as those in the lowest socioeconomic status before and after the policy change. The number of first-time mothers aged 35 years and over was greater in the higher socioeconomic status groups. Women in the higher socioeconomic status groups tended to have delayed childbearing and therefore were at risk of age-related subfertility. In relative terms, all groups were affected by the change, but the highest group experienced the greatest reduction in absolute numbers of fresh cycles. Proportionally, all groups experienced a similar decrease in service uptake. Financial barriers obviously play a role in preventing couples seeking treatment, but disparities in fertility treatment persist even after adjusting for financial factors. This is reflected in all areas of healthcare. Although those in the lower socioeconomic status groups make considerably more visits to publicly funded primary care services they are far less likely to make use of publicly funded specialist services than those in the higher socioeconomic status groups.[15]

A study in Finland found that women from higher socioeconomic groups used in vitro fertilization twice as much as the lower groups in every age group and also spent more of their own money. Women treated exclusively in the private sector received more cycles than those treated exclusively in the public sector, and women treated in both the public sector and the private sector received the most cycles compared to the other two groups. Older women with poorer success rates received more cycles, and costs per live births were far higher than among younger women.[27]

5.2.8 Lifetime tax calculation and benefits of in vitro fertilization-conceived children

Several writers have sought to analyse the costs and benefits of in vitro fertilization-conceived children by putting the costs of the live birth and other state contributions against a lifetime of paying taxes and otherwise contributing to society. This is done by using a generational accounting model to calculate the net present value of average investment costs required to achieve an in vitro fertilization-conceived child. Net present value is the difference between the present value of cash inflows and the present value of cash outflows. Net present value is used in capital budgeting to analyse the profitability of a projected investment or project. The model simulates the direct lifetime financial interactions between the child and the government. Similar analysis has been carried out for Sweden, the USA and the UK.[10, 19, 45] The models assume that average direct transfers are made to the individual, such as child benefit, education, healthcare and pension. In return, the individual transfers resources to the government in the form of taxes based on anticipated average earnings and indirect taxes. The difference between the two is the net contribution the individual makes to the state. In the early stages of life, the state contributes towards education and healthcare costs. As the individual enters the workforce they start making contributions in the form of direct and indirect taxes while still getting some benefits from the state. In old age the individual is likely to be again dependent on the state. The same calculations are made for a naturally conceived child with the only variation being the costs associated with in vitro fertilization treatment. The calculations are based on an individual born in 2005 with a lifespan of 80 years. The breakeven age in Sweden was 40 years for the naturally conceived child and between 41 and 43 years for the in vitro fertilization-conceived child. For the United States the breakeven age was 34 years for naturally conceived children and 36 to 38 years for in vitro fertilization children conceived to mothers younger than 41 years.[19] In the UK, an investment of £12,931 to achieve an in vitro fertilization singleton is actually worth 8.5 times this amount to the UK Treasury in discounted future tax revenue.[10] All of these studies make reasonable assumptions about revenues and costs based on a view of the world as it is today. However, projecting these assumptions 80 years into the future may give us reason to treat them with caution. Also, these studies take a naturally conceived child and an in vitro fertilization-conceived child as equivalent except for the costs of the in vitro fertilization. There is evidence that in vitro fertilization-conceived children are more likely to have a low birth weight, and the possibility of twins, triplets or other multiple births gives rise to considerably higher costs both during pregnancy and afterwards.[45] In addition, births as a result of in vitro fertilization are more likely to have congenital abnormalities than naturally conceived children.[59]

5.2.9 Logic and benefit of single-embryo transfer (SET)

One of the challenges facing assisted reproductive technology treatment is the high rate of multiple births, particularly twins and triplets, which results from the transfer of multiple embryos. There are significant increased risks associated with multiple births for both mothers and babies during pregnancy, at delivery and after birth.[8] The elimination of multiple-embryo transfer and the voluntary adoption of single-embryo transfer have

resulted in a big reduction in multiple births where it has been adopted, and a reduction in the risks associated with them. In the USA, assisted reproductive technology treatment is expensive and there is no funding in 36 states. This can result in clinicians and their patients agreeing to multiple-embryo transfers to maximize the chances of pregnancy from one fresh in vitro fertilization cycle. Where public funding is available assisted reproductive technology treatment becomes more affordable and there is less incentive for multiple-embryo transfer. Single-embryo transfer is a legally enforceable policy in some jurisdictions, such as Belgium, Turkey, New Zealand and the Canadian province of Quebec.[17] In Australia, the reduction of multiple-embryo transfer was brought about by educating clinicians and the public, but embryo transfer practices have not been directly tied to public funding. Assisted reproductive technology is provided almost exclusively through private clinics and embryo transfer practice guidelines, introduced in 2005, are followed by all clinics accredited to the Reproductive Technology Accreditation Committee. In the UK, there is a consensus of opinion among all leading fertility agencies, including the Royal College of Obstetricians and Gynaecologists, and the Royal College of Paediatrics and Child Health, that it would be difficult to reduce multiple births without supportive NHS funding.[11]

The rate of fresh embryo transfer cycles transferring a single embryo varies from 13.5% in the USA, to 22.8% in the UK and 65.3% in Australia/New Zealand.[11] This reflects how the level of treatment subsidy and availability of an adequate publicly funded service can affect affordability and clinical decisions. In many countries clinicians agree that single-embryo transfer is the ideal except under suboptimal conditions where the physician can justify their decision to transfer more than one embryo and use appropriate selection criteria. An example would be an older patient who had a significantly lower chance of success.[5, 11]

5.2.10 Downstream costs of multiple pregnancy and births

Success rates achieved through the use of assisted reproductive technology in the USA are attained through the simultaneous transfer of multiple embryos at the risk of multiple pregnancies. Although assisted reproductive technology cycles account for only 1% of births in the USA, 18% of multiple births result from assisted reproductive technology. Multiple births have significant consequences for public health.[2] A higher rate of preterm delivery in multiple infant pregnancies compromises their survival chances and increases their risk of lifelong disability. There is a fourfold to sixfold increase in infant deaths and cerebral palsy in twins and more than a 15-fold increase in triplet and other higher-order pregnancies, all of which has financial consequences for the parents, third-party payers and the state. A number of countries have enacted strict regulations to control in vitro fertilization practice because of complications associated with multiple pregnancies. Regulation of in vitro fertilization practice is usually connected to public funding and has resulted in a significant reduction in multiple pregnancies without causing a decrease in cumulative pregnancy rates.[2] Apart from the extra medical costs involved during a multiple pregnancy and delivery, the cost of caring for infants and mothers can be substantial, but difficult to quantify.

It is estimated that the decrease in assisted reproductive technology multiple birth rate in Australia between 2002 and 2008 resulted in the saving of AU$47.6 million in public funds in birth admission costs alone.[8] This means that more than half the cost of the growth in assisted reproductive technology services was funded by means of these savings, which were achieved through the greater use of single-embryo transfer. Savings would be greater when the long-term healthcare costs of multiple-birth infants are taken into account. After birth, twins are 3.9 times more likely to be transferred to another hospital for special care, and triplets are 10.6 times more likely to be transferred for special care. The long-term medical, educational and social services costs associated with multiple births are higher than those associated with singleton births. In Australia, Chambers *et al.*[59] found that assisted reproductive technology infants were 4.4 times more likely to have a low birth weight compared with non-assisted reproductive technology infants. Assisted reproductive technology infant birth admissions were 89% more costly than non-assisted reproductive technology infant birth admissions (AU$2,832 and AU$1,502, respectively). Assisted reproductive technology singletons were also more likely to be low birth weight compared with non-assisted reproductive technology singletons, translating into 31% higher birth admission costs (AU$1,849 and AU$1,415, respectively). After combining infant and maternal admission costs, the average cost of an assisted reproductive technology singleton delivery was AU$4,818 compared with AU$13,890 for assisted reproductive technology twins and AU$54,294 for assisted reproductive technology higher-order multiples.[59]

A population study into assisted reproductive technology and non-assisted reproductive technology singletons over their first five years of life involving 226,624 births in Western Australia found that the mothers of assisted reproductive technology children were more likely to be older, first-time mothers and would be delivered by caesarean section. Neonatal rates of mortality for assisted reproductive technology children were three times that of non-assisted reproductive technology children but rates for children aged between six weeks and five years were about the same for both groups. Assisted reproductive technology children were twice as likely to be born prematurely, to be low birth weight, or to be small for gestational age. Assisted reproductive technology children were 20% more likely to be admitted to hospital in their first year of life and were likely to have a higher prospect of hospitalization for all subsequent years of childhood. The mean cost of the birth admission was AU$1,448 for naturally conceived children but AU$3,171 for assisted reproductive technology children.[91] Costs involved in twins, triplets and higher-order multiple deliveries are likely to be even greater.

5.2.11 Costs to tax payer and benefits to society

Assisted reproductive technology is an expensive treatment with a high cost per procedure, but given the population of couples who may need, or avail of, assisted reproductive technology treatments the cost to society is relatively modest in the context of the overall health budget. The perception of how assisted reproductive technology and infertility are perceived in any given society can be a measure of whether or not it represents 'value for money'.[2, 13] Fertility treatments are different to other medical and surgical treatment in that they involve the creation of new life rather than the preservation or enhancement of life. This makes assisted reproductive technology less amenable to conventional health economic methods of analysis.[13] Evaluation techniques which assess society's 'willingness to pay' can be used as a measure of cost-benefit analysis. For all goods and services the price willing to be paid is equivalent to the perceived benefit gained.[2]

5.2.12 Summary: Question 2

In the literature, the rationale for the introduction of state support for assisted reproductive therapies is that it may induce greater equity of access, safer clinical practice and the use of more cost-effective methods.

The direct costs of assisted reproductive technology recorded in the literature nclude the cost of the variety of services of a clinical nature , laboratory fees and hospital or clinic charges which together represent the cost to each patient.

There are also indirect costs reported in the literature such as the cost of treatment complications, patient travel costs, lost productivity, low success rates and multiple births

Excessive costs of assisted reproductive technologies can be the result of poorly crafted systems for public funding which can give rise to perverse incentives and can produce outcomes that are undesirable from clinical, societal and financial points of view. For example, costs of Quebec's publicly funded in vitro fertilization programme where the cost to the taxpayer ranged from Can$43,153 for a single baby born to a woman of 40 to Can$103,994 per singleton baby for those aged 43. For those aged 44 years, the mean cost of failed in vitro fertilization was Can$597,800 – no babies were born to this group. In contrast to this, the average cost of in vitro fertilization treatment per live newborn for women under 35 years was Can$17,919. The literature reported that costs incurred by multiple births were substantial. The maternal and infant cost of twin pregnancy can be three times that of a singleton pregnancy and the cost of caring for multiple-birth infants continues for many years. Healthcare and educational resources for low-birth-weight children can be greater than normal weight children up to age eight or nine years.

The direct benefits of assisted reproductive technology are the increased chance for single women and couples to become parents, particularly women under 40 years, and the increase in live births as a result of assisted reproductive technology increases the young population of a country.

Economic projections, based on lifetime tax calculations (for 80 years), are that the cost of in vitro fertilization-conceived children breaks even at around 40 years compared to 38 years for a normal birth and in vitro fertilization funding by the state represents good value for money (an indirect benefit). Some countries view assisted reproductive technology as a method of redressing declining fertility rates.

Many countries view public funding for assisted reproductive technologies as a method of introducing safer embryo transfer practices and thereby reducing the incidence of multiple pregnancy and its associated complications. It is clear that providing a significant proportion of public funding will encourage women from lower socioeconomic groups to use this intervention but, proportionally, women in the higher socioeconomic groups are more likely to use the service.

5.3 Question 3: What are the criteria for accessing publicly funded assisted reproductive technology (ART) services in a number of jurisdictions?

5.3.1 Introduction

We present data published in peer-reviewed journals or international associations' reports that describe public funding mechanisms and criteria between 2008 and 2016. However, the data available are from different time points and the data are based on primary data collected between 2008 and 2015. All of the data are referenced to their source in the tables so that the reader can check the time points. The data are taken from reports and papers published in English. We were able to check data from English-speaking countries with their original sources but were not able to do this for non-English-speaking countries. Generally, the data we present were consistent between all sources and where the data were not consistent, usually there was a documented change in regulation or funding policy. Section 5.3 should be read bearing these strengths and limitations in mind. We compare and contrast criteria in the countries reviewed and present interesting country examples in the text. We present the criteria for accessing public funding by country in Appendix 9.

5.3.2 Existence of public funding criteria

In the literature, every country reporting that they had a publicly funded assisted reproductive technologies programme had access criteria. There are varying restrictions across countries, including civil or marital status, age, medical indication, previous children, co-morbidity (obesity, anorexia, HIV), child protection, place of treatment provision (i.e., public or private clinic), the type of treatment used or number of allowable treatment cycles or embryo transfers. The place of treatment provision (i.e., public or private clinic), the type of treatment used and number of allowable treatment cycles and number of embryo transfers are covered in the answer to Question 1.

This section will describe restrictions with respect to civil or marital status, age, medical indication, previous children, co-morbidity (obesity, anorexia, HIV) and child protection. The rationale and evidence base for these restrictions are presented in response to Question 4 in Section 5.4.

Appendix 9 presents the criteria extracted from the literature by country, so that the complete criteria by country may be viewed.

5.3.2.1 Civil or marital status

Of the 36 countries with published criteria covering civil or marital status, just over half entitle all adults, regardless of civil or marital status, access to assisted reproductive technologies. Poland is the only country where entitlement is limited to married heterosexual couples (Table 5.15). The exact civil or marital status entitlements are presented in the bulleted list below:

- All entitled (including heterosexual couples, lesbian couples and single women): Australia, Belgium, Bulgaria, Ontario (Canada), Denmark, Estonia, Finland, Greece, Hungary, Israel, Latvia, Luxembourg, The Netherlands, New Zealand, Russia, Spain, Sweden, England and Wales
- Heterosexual couples or lesbian couples in a stable relationship: Norway and Scotland
- Heterosexual couples married or in a stable relationship: Austria, Croatia, Czech Republic, France, Germany, Iceland, Italy, Portugal and Slovenia
- Heterosexual couples married: Poland
- No written criteria: Slovakia
- No publicly funded service : Cyprus, Lithuania, Malta, Romania and Switzerland.

Social infertility can arise because of 'social factors', for example, delay in getting pregnant due to economic needs, or in a relationship with a same-sex partner.[50] Some countries adopt quite restrictive approaches to social infertility, which may prevent people who are socially infertile accessing assisted reproductive technologies and/or public subsidies for such technologies. For example, Austria, Croatia, France, Germany, Italy and Portugal (Tables 15 and 5.16), in addition to insisting on a medical indication as one of the criteria for in vitro fertilization, require treatment seekers to be heterosexual. According to Berg Brigham *et al*., '…the restriction based on sexual orientation and relationship status is unique to fertility treatments among healthcare goods…' p669.[3] However, single women and lesbians are allowed access to assisted reproductive therapies in Australia, Belgium, Bulgaria, Denmark, Estonia, Finland, Greece, Hungary, Israel, Latvia, Luxembourg, the Netherlands, New Zealand, Russia, Spain Sweden and England (Table 15). At the same time, the provision of assisted reproductive technologies is linked to a medical indication in Australia, Belgium, Greece, Hungary, Israel, the Netherlands, New Zealand, Spain, Sweden and England; it is not known whether there is a similar requirement for a medical indication in Bulgaria, Estonia, Latvia and Russia. Since 2008, the trend has been to widen the civil criteria, but it may be that the publicly funded criteria are now limited through the medical indication criteria.

Table 15 Civil or marital status criteria to access a publicly funded assisted reproductive technologies programme, by country, 2008–2016

	Criteria
Country	Civil or marital status (married or living together for a defined period)
Austria	Yes. Heterosexual couples.[3] Marriage and stable relationship in law and guidelines.[65]
Australia	Stable relationship, singles and lesbians allowed.[65]
Belgium	No restrictions.[3, 49] All allowed in law.[3, 65]
Bulgaria	No restrictions.[49] All allowed in law.[65]
Canada (Ontario)	Available to eligible Ontarians of either sex, gender, sexual orientation or family status.[70]
Croatia	Heterosexual couples,[67] marriage or stable relationship required in law.[65]
Cyprus	Not applicable
Czech Republic	Yes[49] Marriage or stable relationship required in law.[65]
Denmark	No restrictions.[3, 49] All allowed in law.,[3, 65]
Estonia	No restrictions[49]
Finland	Yes.[49] All allowed in law.[65, 3]
France	Yes[49] Heterosexual couples.[3, 92] Stable relationship in law and guidelines.[65]
Germany	No [16, 49] in earlier references. Yes (married)[79] for statutory health insurance fund.[67] Heterosexual couples[3] in *de facto* relationships for central fund.[67]
Greece	Yes.[49] No restrictions in law.[3] Stable relationship in law.[65] Single allowed in law.[65]
Hungary	Yes[49] Heterosexual married, stable relationship[67] or single allowed in law.[65]
Iceland	Marriage or cohabitation in law.[40] Heterosexual couples.[67]
Ireland	Not applicable.[49] No restrictions in law.[65]
Israel	Married, stable relationship and singles allowed in law and guidelines.[65]
Italy	Yes.[3, 49] Heterosexual couples.[3] Married and stable relationship allowed in law and guidelines.[65]

	Criteria
Country	Civil or marital status (married or living together for a defined period)
Latvia	All allowed in law[65]
Lithuania	Not applicable[49]
Luxembourg	No restrictions[49]
Malta	Not applicable[49]
Netherlands	No restrictions.[3, 49] All allowed.[3]
New Zealand[73]	All allowed in law.[65] Exclusions that breach Human Rights Act of Bill of Rights Act are not permitted.[93]
Norway	Married, stable relationship, and lesbian couples allowed in law.[65] Singles not allowed[67]
Poland	Not applicable.[49] Heterosexual married couples.[63, 67]
Portugal	Yes, in practice.[3, 49] Heterosexual couples.[3]
Romania	Not applicable[49]
Russia	Married, stable relationship or single allowed in law[65] but 'family code' does not recognize single parents.[67]
Slovakia	No written criteria[49]
Slovenia	Yes.[49] Heterosexual stable relationship in law.[65]
Spain	No restrictions.[3, 49] All allowed in law.[3, 65]
Sweden	Yes.[49] Both heterosexual and homosexual couples.[3] Stable relationship and lesbians allowed in law.[65] Single women can access assisted reproductive services since April 2016.[67]
Switzerland	For private funding: stable relationship allowed in law.[65]
Ukraine	Heterosexual couples and single women.[67]
UK England	No restrictions.[3, 49] All allowed in law.[3, 65] However, clinical commissioning groups have their own individual criteria based on available funding criteria.[78]
UK Scotland	Heterosexual and homosexual couples cohabiting for two years or more.[75, 81] No individual (male or female) can access more than the number of NHS-funded in vitro fertilization treatment cycles supported by NHS Scotland under any circumstances, even if they are in a new relationship.[75, 81]
UK Wales	All including single women and men.[75]

5.3.2.2 Age

5.3.2.2.1 Women

Some countries have a legal upper age limit for accessing publicly funded assisted reproductive technologies which is usually higher than the upper age limit used by publicly funded health services. Both upper age limits are presented in Table 16, but the following bulleted list is based on the age limit used in practice to access public funding. Seventeen countries have an age cut-off of 39 years or under; two countries have no stated age limit.

- In practice, no age limit: Australia and Hungary
- In practice, childbearing age (upper age flexible): Italy
- In practice, <50 years: Greece
- In practice, <45 years: Denmark, Israel and The Netherlands
- In practice, <43 years: Belgium, Croatia, Ontario (Canada), Finland, France, Iceland and Slovenia
- In practice, <42 Years: Portugal and New Zealand
- In practice, <40 years: Austria, Bulgaria, Cyprus, Denmark, Germany, Luxembourg, Norway, Poland, Spain, Sweden, Turkey, England, Scotland and Wales
- In practice, for reimbursement, <39 years: Slovakia
- In practice, <38 years: Latvia
- In practice: <35 years: Ukraine
- Age limit exists but not reported: Czech Republic and Estonia
- No written criteria: Slovakia
- No information: Russia
- No publicly funded service: Lithuania, Malta and Romania

According to Carter *et al.*,[51] '… many countries that do publicly fund assisted reproductive technologies do so with a female age limit…' p89. However, while setting a female age limit seems to be part of most countries' criteria for public funding of assisted reproductive technologies, what is also evident is the variation in female age limits set by different countries and provinces. For example, the variation in the upper female age limit is well documented from international data, as shown in the bullet points above and in Table 16, and this is supported by a recent comprehensive systematic review undertaken by Dunn *et al.*[16] The variation in the upper limit on female age and related conditions is also reported by Berg Brigham *et al*. in their analysis of 2009 ESHRE data from a number of European countries.[3] They analysed 2009 data collected from the ESHRE study of regulatory frameworks in Europe and data they secured from additional legislative research. As part of their analysis, they compared eligibility criteria for public funding of in vitro fertilization in Austria, Belgium, Denmark, France, Finland, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden and the UK. The authors selected these 13 European Union countries for comparative analysis as they met the criteria for providing public funding for in vitro fertilization. In contrast to the general eligibility criteria, six countries (Austria, Finland, Germany, Portugal, Spain and the UK) with no [legal] age limit for access to in vitro fertilization have established age limits only for publicly financed treatment, whereas 'two (Belgium and Denmark) with [legal] age limits reduced it for [publicly] covered treatment'. In countries with strict upper age limits for women, the range is from 39 years in five countries

(Austria, Denmark, Germany, Spain and the UK) to 41 years in Portugal, 42 years in France and Finland, 44 years in the Netherlands and 49 years in Greece, indicating that the most common cut-off for public funding is 39 years.

Berg Brigham *et al.* also provide some useful insight into how countries who do not set upper female age limits for public funding of assisted reproductive technologies deal with the issue of age in practice: 'In countries with soft [child-bearing age] or no age limits, discretion to determine access based on age generally rests with the clinic or doctor, who may rely upon other clinical indications, such as the patient's ovarian reserve, hormonal levels' p669.[3] Italy is an example of such a country.

5.3.2.2.2 Men

Six countries had age criteria for men accessing publicly funded assisted reproductive technologies, and of these, three countries (Austria, Germany and Iceland) specified the age cut-off as 50 years or under (Table 16). Sixteen countries had no age criteria for men accessing publicly funded assisted reproductive technologies. Nine countries had no published information indicating if there was age criteria for men accessing publicly funded assisted reproductive technologies.

There appears to be either limited reporting of, or an absence of established criteria for, the paternal age limit for accessing public funding for assisted reproductive technologies. According to Menon *et al.*,[30] who completed a systematic review to assess the scientific evidence of certain patient characteristics on the safety and effectiveness of in vitro fertilization, '…While semen volume seems to decrease with paternal age, whether or not this translates into reduced reproductive function or poorer success with in vitro fertilization remains unclear…' p432. The 2016 National Infertility Group report for Scotland did not locate solid evidence for a male upper age limit in their report and recommended that a future group discuss and agree a national age limit for males.[76]

Table 16 Age criteria to access a publicly funded assisted reproductive technologies programme, by country, 2009–2015

Country	Maximum and minimum age for woman	Maximum and minimum age for man
Austria	None, in law.[3, 49] <40 years[3, 16]	None, in law[49] <50 years[3]
Australia	No age limit[16, 43, 51]	No information
Belgium	Yes[3, 49] <45 years in law.[3] <40 years in practice.[3] <43 years or upper age limit = 42.[16]	None[49]
Bulgaria	Yes[49] 18 to 40 years[1]	None[49]
Canada (Ontario)	Yes[70] <43 years for in vitro fertilization.[70]	No information
Croatia	<43 years or upper age limit = 42.[67]	No information
Cyprus	<40 years[67]	Not applicable
Czech Republic	Yes,[49] age cut-off not recorded.[67]	None[49]
Denmark	Yes[3, 49] <45 years in law.[3, 67] <40 years in practice.[3, 16]	None[49]
Estonia	Yes[49]	None[49]
Finland	Yes,[49] ideally 40 or younger but may cover women up to 43 years.[67] No restrictions in law.[3] No age restrictions.[16]	None[49]
France	Yes[3, 49] Child-bearing age.[3, 92] <43 years in practice.[3, 16]	Yes,[49] reproductive age.[67]
Germany	None in law.[3, 16] Yes,[49] in practice. >25 and <40 years [3, 16, 67, 79]	None[49] >25 and <50 years.[3, 67, 79]
Greece	Yes[3, 49] <50 years[3]	None[49]
Hungary	No,[49] age is linked to cause of infertility.[67]	None[49]
Iceland	Yes, 42 in practice and 45 years in law.[40]	Yes, 50 years in law.[40]
Ireland	Not applicable	Not applicable[49]
Israel	<46 years[16] Up to 44 years if uses own eggs.[4] Up to 51 years if uses a donor egg.[4] Up to 45 years if uses own eggs.[4, 21] Up to 54 years if uses a donor egg.[94] There are inconsistencies with respect to age	No information

Country	Maximum and minimum age for woman	Maximum and minimum age for man
	criteria in Israel; the <46 years for own eggs is the most commonly quoted.	
Italy	Yes.[3, 49] Childbearing ag.[3, 16]	None[49]
Latvia	<38 years[65]	No information
Lithuania	Not applicable[49]	Not applicable[49]
Luxembourg	Yes,[49] <40 years[67]	None[49]
Malta	Not applicable	Not applicable[49]
Netherlands	Yes[3, 49] <45 years[3, 16]	None[49]
New Zealand[73]	Not specified, but the age of the female partner reflects the probability of conceiving with treatment and is a consideration in the weighting of the points awarded under the priority criteria scoring.[93] Since 1999, funding restricted to those <40 years old.[16, 18] <40 years scores 10 points on clinical priority access criteria, while being aged between 40 and 41 scores five points and being aged 42 scores one point.[20]	Not mentioned[73]
Norway	In practice, <40 years for publicly funded treatment.[67]	No information
Poland	Not applicable.[49] <40 years.[63]	Not applicable[49]
Portugal	Yes[49] Not in law[3] National health service criteria:[35] – 'First- line treatment' for women under 42 years – 'Second-line treatment' for women under 40 years Not clear what first-line and second-line treatment refers to.	None
Romania	Not applicable[49]	Not applicable[49]
Russia	No information	No information
Slovakia	No written criteria.[49] For reimbursement <39 years.[67]	No written criteria[49]
Slovenia	Yes,[49] upper age limit is 43 years.[67]	No[49]
Spain	Yes, in practice.[49] None in law.[3, 16] Childbearing age 'soft'.[3]	No[49] 18–55 years for men.[67]

Country	Maximum and minimum age for woman	Maximum and minimum age for man
	18–39 years for women.[67]	
Sweden	Yes[3, 49] Childbearing age.[3, 16] The cut-off is 40 to 45 years depending on the situation.[67]	Yes,[49] must not be above 56 years[67]
Switzerland	Not applicable	Not applicable
Turkey	24 to 39 years[67]	No information
Ukraine	<35 years[67]	No information
UK England	Yes[49] Not in law.[3] <40 years in practice.[3] NICE recommends that in vitro fertilization should be offered to women up to 42 years of age with certain criteria to be met.[80] When women aged under 40 years who have not conceived reach the age of 40 years during treatment complete the current full cycle but do not offer further full cycles.[80] In women aged 40–42 years who have not conceived, offer one full cycle of in vitro fertilization, with or without intracytoplasmic sperm injection, provided the following three criteria are fulfilled: – They have never previously had in vitro fertilization treatment. – There is no evidence of low ovarian reserve. – There has been a discussion of the additional implications of in vitro fertilization and pregnancy at this age.[80]	None[49]
UK Scotland	Up to 40 years (fresh cycles) and completed by 41st birthday (frozen cycles).[75, 76, 81]	The 2016 National Infertility Group report for Scotland recommends that a future group discuss and agree a national age limit for males.[76]
UK Wales	Women aged under 40 years; Women aged between 40 and 42 years who meet the access criteria are entitled to one cycle of in vitro fertilization or intracytoplasmic sperm injection (in line with NICE guidance) provided that they meet the following criteria: – The patient has never previously had in	No information

Country	Maximum and minimum age for woman	Maximum and minimum age for man
	vitro fertilization treatment. – There is no evidence of low ovarian reserve. – There has been a discussion of the additional implications of in vitro fertilization and pregnancy at this age.[75] Follow NICE recommendations. However, health boards may have additional criteria that have to be met before a woman falling into a certain age range can have in vitro fertilization.[95]	

5.3.2.3 Embryo transfer policy

There is some variation in the number of embryos transferred at a single point in time. Older age and the likelihood of multiple births are the main influencing factors. Eight countries specify, either in law or through agreement, that women in their early to mid-thirties will only have a single embryo transferred for the first two or three attempts. This practice is in order to minimize the number of multiple births and reduce the complications associated with multiple births, such as premature delivery, low birth weight, need for assisted delivery and congenital abnormalities; all of these outcomes place further strain on expert and financial resources. Seven countries have no stated maximum number of embryos that can be transferred at a single point in time. The bulleted list below presents a summary of the number of embryos that can be transferred at a single point in time in each country:

- Limit to single-embryo transfer for young women: Austria, Australia, Belgium, Israel, New Zealand, Norway, Sweden and UK England
- Up to two embryos transferred for young women: Czech Republic, Denmark, Finland, The Netherlands, Russia, Slovenia, Spain and UK Scotland
- Up to three embryos transferred: Bulgaria, France, Hungary and Latvia
- No limit on the number of embryos transferred: Estonia, Germany, Greece, Italy, Luxembourg, Portugal and Slovakia

Countries that promote single-embryo transfer for women in their thirties usually allow the transfer of two embryos for young women who experience repeated failure and for women over 40 years. The exact embryo transfer policy for each country is presented in Table 17.

New Zealand has linked policy regarding embryo transfer to public funding for in vitro fertilization treatment. Assisted human reproduction legislation in New Zealand does not stipulate the number of embryos to transfer, and until 2005, the government funded only one complete in vitro fertilization cycle for eligible patients. Since 2005, patients eligible for funded in vitro fertilization treatment who agree to single-embryo transfer but fail to achieve a pregnancy are funded for a second in vitro fertilization cycle. Within a short time

of the new policy being introduced, 90% of patients in the public treatment system agreed to single-embryo transfer.[14]

Since 2003, Belgian law has tied embryo transfer policies to state funding for in vitro fertilization in an attempt to reduce the number of multiple births. The number of embryos transferred is limited by law, using a formula that considers a woman's age and treatment history.[3, 14] According to Peeraer *et al.*,[34] 'Before legislation, a maximum of two to three embryos were transferred. Since the new legislation in 2003, embryo transfer is legally restricted depending on female age and cycle rank.'

In Canada,[44] Quebec became the first province to introduce full public funding for assisted reproductive technology treatment to reduce multiple births from in vitro fertilization, increase Quebec's births of live babies per year, and help infertile couples to conceive in a safe manner. According to Shaulov *et al.* (2015),[44] '…Public coverage of assisted reproductive technologies including in vitro fertilization in the province of Quebec was implemented on August 5, 2010. To ensure a decrease in multiple birth rates, a single-embryo transfer policy was established, as several studies have shown it to be successful in this respect…' p1385. The assisted reproductive policies were under review at the time of writing this report.

Denmark and Australia are two countries that have introduced quite different embryo transfer limits attached to public funding. In Denmark, treatment with assisted reproductive technologies is available free of charge at public clinics within the National Health System. In vitro fertilization is generally only offered to couples without a child, with a maximum of two fresh embryo transfers are allowed for women under 40 years and three fresh embryo transfers for women over 40 years. The waiting time from referral to treatment was around three months in 2011[38] According to Chambers *et al.*,[8] '…Australia has been a world leader in reducing the incidence of multiple births as a result of assisted reproductive therapies through a voluntary shift to single-embryo transfer. This reduction in the number of embryos transferred in Australia has occurred against a backdrop of supportive public funding of assisted reproductive therapies over the past decade' p594.

Table 17 Number of embryos transferred under public funding criteria for assisted reproductive technologies, by country, 2009–2015

Country	Number of embryos transferred allowed
Austria	Single.[16] Reinforcement of single-embryo transfer in young patients. No more than 2 embryos transferred up to age 35, and first attempt up to age 40 years. Embryo transfer of 3 embryos after repeated failures for those up to 40 years. From 40 years on, 3 or more allowed for embryo transfer.[65]
Australia	One fresh embryo in first treatment cycle for those under 35 years old. Maximum of 2 embryos if over 38.[16, 65]
Belgium	Yes.[34, 49] Age <36 years, single for first cycle and double for subsequent cycles. 36–39 years double for first two cycles and triple for subsequent cycles; 40–42 years, no restrictions.[16]
Bulgaria	From one to three embryos, very occasionally up to four. There are specific rules depending on the embryo stage, assisted hatching, maternal age, number of attempts, etc.[65]
Croatia	Not reported.[65]
Cyprus	No information
Czech Republic	Two frozen/thawed embryos are recommended to be transferred, but in older women, more can be transferred.[65]
Denmark	Women below 40 years of age, maximum of 2 embryos; women 40 years or over, maximum of three embryos.[65]
Estonia	No limit[49]
Finland	Not regulated and no limit stated in policy but single or double is usual practice.[16]
France	Maximum three; need to document the rationale.[65]
Germany	No limit[49]
Greece	No limit[49]
Hungary	Age 40 years or below, three embryos allowed; age over 40 years, four embryos[65]
Israel	One embryo unless medical exception.[65] If medical exception, double for first three cycles. Four may be transferred under special circumstances.[16]
Italy	No limit[49] Physician's decision.[16]
Latvia	Not more than three embryos. New guidelines were under preparation at the time of reporting.[65]
Lithuania	Not applicable[49]
Luxembourg	No limit[49]
Malta	Not applicable[49]
Netherlands	Maximum two embryos transferred.[16]
New	Careful consideration of the number of embryos transferred in in vitro

Country	Number of embryos transferred allowed
Zealand	fertilization: Transfer of a single fresh or thawed embryo will always be used in a public funded cycle.[18] Transfer of two embryos may be considered where the woman has not become pregnant despite transfer of four or more separate embryos, and the risk of multiple pregnancies is low. A second single-embryo transfer cycle may be given to women <36 years.
Norway	Single-embryo transfer preferred[16]
Poland	Not applicable[49]
Portugal	No limit[49]
Romania	Not applicable[49]
Russia	One or two embryos. Informed consent form should be signed by patient in case of transfer of three embryos.[65]
Slovakia	No limit[49]
Slovenia	Maximum three embryos by law; maximum two in practice. Single for first two attempts in favourable cases where woman is under 35 years of age.[65]
Spain	Depending on woman's age and number of high-quality embryos:[16, 65] ≤30 years: single or double. 30–37 years: single or double for the first two cycles and triple if they fail. >37 years: double for first cycle and then triple.[16]
Sweden	Law and guidelines state the same: one as a rule,[16] exceptionally two, never three or more.[65]
Switzerland	No public funding; maximum three.[65]
Ukraine	No information
UK England	NICE recommends:[80] For women aged under 37 years: In the first full in vitro fertilization cycle, use single-embryo transfer. In the second full in vitro fertilization cycle, use single-embryo transfer if one or more top-quality embryos are available. Consider using two embryos if no top-quality embryos are available. In the third full in vitro fertilization cycle, transfer no more than two embryos. For women aged 37–39 years: In the first and second full in vitro fertilization cycles, use single-embryo transfer if there are one or more top-quality embryos. Consider double-embryo transfer if there are no top-quality embryos. In the third full in vitro fertilization cycle, transfer no more than two embryos. For women aged 40–42 years: consider double-embryo transfer.
UK Scotland	Maximum of two embryo transfers (in vitro fertilization or intracytoplasmic sperm injection) funded by NHS (under review).[75, 81] Single-embryo transfer preferred.[76]

Country	Number of embryos transferred allowed
UK Wales	No information

5.3.2.4 Medical indication

Medical indication

Fourteen jurisdictions require a medical indication (such as a diagnosis of medical infertility or cancer that requires treatment but has a high likelihood of survival) to access publicly funded assisted reproductive technologies; four jurisdictions do not have a medical indication requirement (Table 18). There was no information available for eight countries.

- Medical indication required: Austria, Belgium, Croatia, Czech Republic, France, Germany, Greece, Italy, The Netherlands, New Zealand, Serbia and Montenegro, Portugal, Spain and Sweden
- Unexplained infertility: Hungary, Israel, Poland, Slovakia, Slovenia, England and Scotland
- No medical indication required: Ontario (Canada), Denmark, Finland and Wales
- Status not known: Australia, Bulgaria, Estonia, Iceland, Latvia, Luxembourg, Norway and Russia
- No publicly funded service: Cyprus, Lithuania, Malta and Romania

A number of countries allow people to have assisted reproductive technologies in order to prevent transmission of a hereditary or serious infectious disease to offspring, whereas other countries require screening for blood-borne viruses and sexually transmitted diseases, the presence of which may delay or militate against receiving assisted reproductive technologies considering the risk to the future child.[27] New Zealand, England, Scotland and Wales clearly describe what they mean by medical indication (Table 18).

According to Berg Brigham *et al.*,[3] who analysed data on 13 European Union countries that publicly subsidized assisted reproductive therapy, 'In seven of the 13 countries, a medical indication must form the basis for a demand for in vitro fertilization, regardless of whether the treatment is publicly covered. Austria, Germany and Italy are particularly restrictive, limiting treatment to diagnosed infertility, while in addition to infertility, France, the Netherlands, Portugal and Sweden also permit the use of in vitro fertilization to avoid the transmission of serious diseases…' p669. Birenbaum-Carmeli[4] highlights the restrictive situation in Austria which provides public reimbursement for 70% of the cost, and covers only women under forty years with tubal factor and men under 50 with sperm impairment. According to Berg Brigham *et al.*,[3]'…six [EU] countries have taken a more liberal approach to access to in vitro fertilization. These [six] countries, Belgium, Denmark, Finland, Greece, Spain and the UK, do not require a medical indication for access to IVF treatment…' p669. However, other more recent sources reveal that Belgium, Greece, Spain and the UK require a medical indication to access public funding (Table 18).

The criteria around providing subsidy for assisted reproductive therapies outside Europe also commonly requires a medical indication as a basis for access to treatment. For example,

according to Carter and Braunack-Mayer,[50] '… [In Australia] public funding [for assisted reproductive technologies], flowing from the federal and not the state government, continues to require the presence of a medical condition [clinical infertility in the patient] …' p464. This criterion for accessing publicly subsidized assisted reproductive technologies in Australia is often overlooked in the literature, with claims that Australia provides unlimited access. However, in countering arguments that Australia is unique in not limiting access to funding for assisted reproductive technologies services, Carter *et al.*[51] argue that, '…On its own, this comment is misleading. Assisted reproductive technologies funding continues to be limited in Australia on at least three fronts. First, funding is officially available for medical infertility only…Second, a co-payment is frequently required…Third, for any one person, funding is capped annually but not over the course of a lifetime…' p87.

Table 18 Medical indication to access publicly funded assisted reproductive technologies, by country, 2009–2015

Country	**Only provided for those with medical indication**
Austria	Yes[3] and level of coverage linked to infertility diagnosis:[16] tubal factors for women and sperm impairment for men.[5] Unfulfilled desire to have children is **not** considered a disease.[67]
Australia	… public funding [for assisted reproductive therapies], flowing from the federal and not the state government, continues to require the presence of a medical condition [clinical infertility in the patient].[50]
Belgium	Not in law[3] Yes, in practice[3]
Canada (Ontario)	No, open to eligible patients with medical or non-medical infertility.[70] Access to fertility preservation, such as egg and sperm preservation, will be offered to people for medical reasons only, such as for people who undergo cancer treatment and who may be at risk of infertility in connection with that treatment.[70]
Croatia	Yes, infertility is defined as a disease.[67]
Cyprus	Yes, infertility[67]
Czech Republic	Yes, medical infertility[67]
Denmark	No[3]
Finland	No[3]
France	Yes.[3, 92] Must be a medical cause of infertility[67] or prevention of transmission of a serious disease.[3]
Germany	Yes[3]
Greece	Not in law[3] Yes, in practice[3]
Hungary	Yes, infertility[67]
Israel	Yes, infertility
Italy	Yes[3]
Netherlands	Yes,[3] or prevention of transmission of a serious disease.[3]
New Zealand[73]	People/couples' eligible for publicly funded health services must also meet the eligibility criteria for the assisted reproductive technology

Country	Only provided for those with medical indication
	service: • Inability to achieve pregnancy after at least one year of unprotected intercourse to attempt pregnancy • Having biological circumstances that prevent them from attempting pregnancy • Inability to carry a pregnancy to term • Being at risk of passing to their children a familial single gene disorder, a familial sex-linked disorder, or familial chromosomal disorder • Being about to undergo publicly funded clinical treatment (such as cancer treatment) that may permanently impair their future fertility, and who are likely to survive that treatment and who have not previously had children.[73]
Poland	Yes, infertility[63, 67]
Portugal	Yes,[3] medical infertility[67] or prevention of transmission of a serious disease.[3]
Serbia and Montenegro	Yes, infertility as a result of a disease of the reproductive organs[67] (presented jointly in report)
Slovakia	Yes, infertility[67]
Slovenia	Yes, infertility[67]
Spain	Not in law[3] Yes, in practice[3]
Sweden	Yes,[3] or prevention of transmission of a serious disease.[3]
UK England	Not in law[3] Yes, in practice[3] Infertility,[67] or identified cause of fertility or infertility that has lasted three years.[67] NICE recommend that couples who have been trying to get pregnant through regular unprotected sex for two years, or who have had 12 cycles of artificial insemination, are suitable.[80]
UK Scotland	Yes. Couples must have been cohabiting in a stable relationship for a minimum of two years:[76] • Infertility with an appropriate diagnosed cause of any duration • Unexplained infertility of at least two years' duration; or • Six to eight cycles of donor insemination for same sex couples.[81] NHS funding may be given to those patients who have previously paid for in vitro fertilization treatment, if in the treating clinician's view, the individual clinical circumstances warrant further treatment.[75, 76, 81] Neither partner to have undergone voluntary sterilization, even if sterilization reversal has been self-funded.[76]
UK Wales	Yes. In vitro fertilization on the NHS in Wales is available for couples who do not have any living children (biological or adopted) or where one of the partners does not have any living children (biological or adopted).[75]

5.3.2.5 Health behaviours or morbidities

In the literature, six countries reported that certain health behaviours or morbidities precluded or delayed access to in vitro fertilization or intracytoplasmic sperm injection(Table 19).

- Belgium did not provide specific details about the behaviours or morbidities.
- Germany indicated that recipients could not be HIV positive.
- New Zealand, England, Scotland and Wales provide detailed health behaviour and morbidity criteria that need to be addressed before in vitro fertilization or intracytoplasmic sperm injection can be considered. All four countries have body mass index restrictions. New Zealand has restrictions at the upper end of the body mass index scale, whereas the other three countries have restrictions on both ends of the body mass index scale. All four countries require that the client has not been smoking for at least three months prior to treatment.

Wales, Scotland and New Zealand mention alcohol consumption as one of the criteria, but their criteria for alcohol differ. New Zealand discusses alcohol consumption with the individual but does not set limits. Wales recommend that potential clients can drink alcohol at low-risk levels, whereas England recommends that clients avoid alcohol, and Scotland recommends that clients abstain from alcohol and other drugs. Scotland also precludes those prescribed methadone treatment for an opiate addiction from accessing in vitro fertilization or intracytoplasmic sperm injection and say that they must be off such treatment for at least one year before they will be considered. Both New Zealand and Scotland mention an adequate ovarian reserve whereas New Zealand recommends treatment for hydro salpinges.

We could not find any information on health behaviours or morbidity criteria in the published literature for Australia, Austria, Bulgaria, Canada Ontario, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Iceland, Israel, Italy, Latvia, Luxembourg, Netherlands, Norway, Portugal, Russia, Slovenia, Spain and Sweden. It is likely that such information would be presented in the national language.

There is no publicly funded service in Cyprus, Lithuania, Malta and Romania.

New Zealand introduced the Clinical Priority Access Criteria (CPAC) to assist in prioritizing publicly funded patients for elective surgery and assisted reproductive technologies. According to Farquhar *et al.*,[18] '…the introduction of the Clinical Priority Access Criteria enabled all eligible couples to be able to access initially one in vitro fertilization treatment, and from 2005 this was increased to two cycles in exchange for accepting a policy of single-embryo transfer for women aged, 36 years [and under]…' p2287. Compliance with the requirements of the clinical priority access criteria in New Zealand is helped by the ancillary supports that patients receive to improve other aspects of their health and lifestyle. For example, patients are encouraged to examine their eating and smoking habits. Farquhar *et al.*[18] state that '…By encouraging lifestyle changes, such as weight loss and smoking cessation, the message about healthy body mass index and smoke-free status before

pregnancy is reinforced… by insisting on such policies, obstetric complications associated with high body mass index and multiple pregnancies should be reduced' p2287. However, Farquhar *et al*. [96] (2011) suggest that the Hunault model for predicting those who are least likely to conceive spontaneously among those with unexplained subfertility is superior to New Zealand's clinical priority access criteria because it is based on evidence validated by over 3,000 cases. The Hunault system would greatly increase the number of patients receiving funding for treatment. The authors claim that the clinical priority access criteria system, used in New Zealand, was developed for funding reasons and the Hunault model was not introduced because it would increase entitlement.

Table 19 Health behaviours or morbidities that delay or prevent access to a publicly funded assisted reproductive technologies programme, by country, 2009–2015

Country	Other health behaviours or morbidities
Belgium	Yes, not mentioned in detail, only in general terms.[65]
Germany	People diagnosed HIV positive not treated.[79]
New Zealand[73]	Women should be smoke-free for three months.[18, 93] Women with a body mass index score higher than 32kg/m^2 should be given a stand-down period and classified as 'active review', to see if they can achieve a lower body mass index score, and a weight improvement programme should be instituted before treatment is begun.[93] Adequate ovarian reserve.[93] Women with hydro salpinges should be treated prior to in vitro fertilization or intracytoplasmic sperm injection.[93]
UK England	The Department of Health has approved a set of standardized access criteria for NHS fertility treatment developed by the patient support organization, Infertility Network UK.[78] Some clinical commissioning groups apply additional criteria that affect access to NHS-funded in vitro fertilization treatment. This includes the woman: • being a healthy weight (BMI range 19–30) • not smoking • not having children from this or any previous relationships • being within specific age ranges (some clinical commissioning groups will only fund women aged under 35 years).[78] The NHS advises that maintaining a healthy weight and avoiding alcohol, smoking and caffeine during treatment may improve a woman's chances of having a baby with in vitro fertilization.[78]
UK Scotland	Adequate ovarian reserve.[75] Both partners must be nicotine free and non-smoking for at least three months before referral for treatment and they must continue to be nicotine free and non-smoking during treatment. Both partners must abstain from illegal and abusive substances. Both partners must be methadone free for at least one year prior to referral for treatment and continue to be methadone free during treatment. Neither partner should drink alcohol prior to or during the period of the pregnancy. Body mass index score of female partner must be above 18.5 and below 30.[75, 76, 81]

Country	Other health behaviours or morbidities
UK Wales	Patients must have a body mass index score of 19 to 30 (inclusive).[75] Follow NICE recommendations. However, health boards may have additional criteria that a woman needs to meet before she can have in vitro fertilization, such as being a healthy weight; not smoking, drinking below low-risk limits; taking folic acid; regular cervical smear; regular health checks.[95]

5.3.2.6 Children

5.3.2.6.1 Existing children

Countries were not asked directly in any of the literature reviewed whether parents with children from their current or a previous relationship could access in vitro fertilization or intracytoplasmic sperm injection. Some countries volunteered such information in their guidance documents (Table 20).

New Zealand, England and Scotland clearly state that already having children will either contribute negatively to the client's case for in vitro fertilization or intracytoplasmic sperm injection therapy or preclude the client from having such therapy. In Scotland, previous sterilization also precludes clients from therapy.

On the other hand, France and Israel allow a couple to conceive up to two children using in vitro fertilization or intracytoplasmic sperm injection, although the criteria in France are much stricter. They do not make any statement on existing children conceived naturally in a couple's current or a previous relationship.

Table 20 Whether existing children prevent access to a publicly funded assisted reproductive technologies programme, by country, 2009–2015

Country	Therapy not permitted if have existing children
France	No[49] in law and regulation. Maximum four cycles allowed.[3, 16] However, if live birth achieved, same treatment options available for a further pregnancy.[3, 72]
Israel	Allowed up to two children through in vitro fertilization[65]
New Zealand[73]	Having children or a previous sterilization will contribute negatively to the priority criteria.[93]
UK England	Yes.[49] Having children from this or any previous relationship precludes you from therapy.
UK Scotland	Neither partner previously sterilized.[75, 81] Up to 2013, only couples without children were eligible for assisted reproductive technology.[81] National Infertility Group Report 2013 recommended that a couple may be suitable for in vitro fertilization if one partner had no genetic children and met all other criteria after 2015.[81] From September 2016, if one partner has no biological child then a couple is considered suitable for assisted reproductive technologies.[76]

5.3.2.6.2 Welfare of any future child

Only seven countries are known to consider the future welfare of the prospective child as part of the assessment for public funding for assisted reproductive technologies (Table 21). The literature does not present what information is gathered to make a decision. One country followed the child after birth to monitor its welfare. Another two countries establish the legal parents of the child at birth.

- Definitive criteria with respect to child welfare before fertilization: Australia, Finland, France, New Zealand, Slovenia, Sweden and England
- Definitive criteria with respect to child welfare after birth: Denmark, Italy, Latvia
- No reported criteria with respect to child welfare: Austria, Belgium, Bulgaria, Czech Republic, Estonia, Germany, Greece, Hungary, Portugal and Slovakia
- No information: Ontario (Canada), Croatia, Iceland, Israel, Luxembourg, the Netherlands, Norway, Russia, Spain, Scotland and Wales
- There is no publicly funded service in Cyprus, Lithuania, Malta and Romania.

Table 21 Whether welfare of future child considered when accessing publicly funded assisted reproductive technologies programme, by country, 2009–2015

Country	Welfare of any future child (prospective parents' HIV status, criminal record, child protection)
Australia	Yes, welfare of offspring of paramount importance. Individuals considered to be unsuitable parents can be refused treatment.[65]
Denmark	After birth, the welfare of the child is followed in the Danish birth register.[65]
Finland	Yes, some limitations on the performance of assisted reproductive treatments, based on consideration of the welfare of the child.[65]
France	Doctors can decide on an individual basis who cannot have assisted reproductive technology in the interests of any potential child.
Italy	Legal status after birth. Article 8 of Law 40/2004 equalizes babies conceived artificially and naturally, to legitimate offspring conceived naturally.[65]
Latvia	Legal status after birth established.[65]
New Zealand	Yes, health and well-being of children 'an important consideration'.[65, 73] Access is refused if there are situations that compromise the safety of the couple or the child.[93]
Slovenia	Yes, the best interests of the child should be respected in infertility treatment.[65]
Sweden	Yes, parents (to be) should not be too old or sick and of reasonably good psychosocial status, to ascertain a reasonably smooth childhood.[65]
UK England	Yes, in accordance with Human Embryo Fertilization Embryology Authority Code of Practice, a woman shall not be provided with treatment services unless account has been taken of the welfare of any child who may be born as a result of the treatment (including the need of that child for supportive parenting) and of any other child who may be affected by the birth.[65]

5.3.3 Summary: Question 3

In the literature, every country reporting that they had a publicly funded assisted reproductive technologies programme had access criteria. There are varying restrictions across countries. Female age and medical indication are the most common criteria used to decide eligibility for publicly funded assisted reproductive therapies. Single-embryo transfer is a criterion used to minimize the number of multiple births and reduce the complications associated with multiple births as these outcomes place a strain on expert and financial resources. Of the criteria used to limit access to public funding, female age, smoking, body mass index, and single-embryo transfer have some clinical and/economic evidence in the literature to support their use.

- There is some variation in the number of embryos transferred at a single point in time. Older age and the likelihood of multiple births are the main influencing factors. Eight out of 24 countries specify, either in law or through agreement, that women in their early to mid-thirties will only have a single embryo transferred for the first two or three attempts.

- Nineteen out of 36 countries entitled heterosexual couples, lesbian couples and single people to public funds for assisted reproductive technologies.

- Some countries have a legal upper age limit for accessing publicly funded assisted reproductive technologies which is usually higher than the upper age limit used by publicly funded health services in the same country. The majority of countries (17) had an age cut-off of 39 years or under to access public funding. Two countries have no stated age limit.

- Fourteen jurisdictions require a medical indication (diagnosed infertility or cancer) to access publicly funded assisted reproductive technologies whereas seven require a diagnosis of unexplained infertility.

- In the literature, six countries reported that certain health behaviours or morbidities that precluded or delayed access to in vitro fertilization or intracytoplasmic sperm injection. New Zealand, England, Scotland and Wales provided detailed health behaviour and morbidity criteria that needed to be addressed before in vitro fertilization or intracytoplasmic sperm injection could be considered. All four countries have (Body Mass Index (BMI) restrictions and require that the client has not been smoking for at least three months prior to treatment. Three countries mention alcohol consumption as one of the criteria, but their criteria for alcohol consumption differ. Scotland recommends that clients abstain from alcohol and other drugs. Both New Zealand and Scotland mention an adequate ovarian reserve whereas New Zealand recommends treatment for hydro salpinges.

- New Zealand and England clearly state that already having children will either contribute negatively to the client's case for in vitro fertilization or intracytoplasmic sperm injection therapy or preclude the client from having such therapy.

Only seven countries are known to consider the future welfare of the prospective child as part of the assessment for public funding for assisted reproductive technologies.

5.4 Question 4: What are the countries' justifications for their criteria for accessing publicly funded assisted reproductive technology services and are these justifications supported by clinical evidence?

5.4.1 Introduction

This section will attempt to identify the likely justifications that countries use to support their claim that certain criteria should be set for people using state funds to purchase assisted reproductive technologies to overcome their infertility. At the outset it is important to say that we could not find any papers in the peer-reviewed literature we reviewed that have explicitly asked this question. Therefore, it was necessary to draw on many papers to extract small relevant pieces of information to begin to help us describe and understand the rationale for publicly funding assisted reproductive technologies. From reading an initial set of potential papers for the review, we identified some recurring criteria that most countries set for excluding certain people from accessing public funding for assisted reproductive technologies treatment. For example, female age, the presence of a medical indication and restrictions in the number of embryo transfers were part of the criteria in many countries (see Question 3), so we continued to extract data from all our papers to identify the rationale and evidence base for assisted reproductive technologies.

From a clinical and economic perspective, the variables: upper female age limit, presence of a medical indication (diagnosed medical infertility) and restrictions in the number of embryo transfers have been put forward as necessary criteria to set limits on the services provided and the number of women who may present for treatment requiring state funding. The most common rationale given for choosing the three variables as part of the criteria is that by exerting some control over these variables, countries and their healthcare systems implement cost controls, reduce multiple births and avoid adverse health risks to mother and child. However, as the information presented in this section demonstrates, there is widespread debate around the merits and morals of including the criterion age. Despite strong evidence to suggest that single-embryo transfers are both cost-effective and a means of reducing health risks to mother and child, there is variation in the number of countries that include single-embryo transfer in their criteria. There are also disputes about the requirement of a medical diagnosis of infertility, on the grounds that it discriminates in favour of heterosexual couples. We hope to tease out the rationale behind these issues in answering Question 4 and examine the evidence that is available to justify the inclusion of the above three access criteria to state funding for assisted reproductive technologies.

As for other parts of clinical and economic criteria (such as BMI, smoking, alcohol or drug consumption, existing children, legal status of the child and welfare of the child), which were reported in the literature we reviewed, we summarize the findings from recent systematic reviews to support the inclusion of an upper BMI level and smoking cessation strategies in access criteria to assisted reproductive technology treatment. In addition to the clinical

criteria that we identified in the papers reviewed, we also noted that a number of authors suggest that a state's (Estonia, Korea, Israel and Sweden) need to reduce its demographic deficit often influenced decisions to allocate state funding for assisted reproductive technologies and wish to identify the beneficiaries of such funded treatment. We took the construct of demographic deficit and extracted data from other papers to assess the utilization of this thinking in many jurisdictions. We found some evidence for the slow spread of this thinking, and in Israel, we found that it was reported to be at the heart of government decisions on public funding for assisted reproductive technologies treatment. For example, it has been suggested that Israel's generous funding policy for assisted reproductive technologies is often associated with the state's pursuit of extending the Jewish population. We will examine this claim further in the text and the rationale and evidence behind it.

Finally, we identified a number of papers which reported the influence of political lobbying, of sociocultural concerns and fiscal restraint and changing patterns in people's behaviour resulting in delayed childbearing age, as potentially determining factors in the minds of policy-makers when deciding to allocate funding for assisted reproductive technologies and the likely beneficiaries of such treatment. What emerges at the end of this exploration is that national policies are a hybrid of political, cultural and economic pressure combined with science leading to a publicly acceptable or pragmatic approach to funding assisted reproductive technologies in each individual country.

5.4.1.1 Female upper age limit as criteria for accessing public funding

Most jurisdictions include an upper female age limit as part of the criteria to gain access to public funding for assisted reproductive technology to treat infertility[51] with variation between age cut-off points in many jurisdictions.[36, 3, 16] There is some evidence for including a female upper age limit as part of the criteria for accessing publicly funded assisted reproductive technologies (see Question 3); however, it comes with caveats and a call by some for further investigation to determine appropriate cut-off points.

Menon *et al*. undertook a systematic review to determine the potential impact of patient characteristics on the safety and effectiveness of in vitro fertilization. They included 10 reviews and 7 primary studies. The design of the studies included in the reviews and the primary studies were retrospective observational studies from which data on relevant variables were analysed as part of secondary data analysis from larger studies. The authors report that '…Although the systematic reviews were of high quality, they primarily comprised observational studies, most of which did not control for potential confounders. Consequently, the validity of results is limited and should be interpreted conservatively…' p432.[30]

Menon *et al*. go on to say that the majority of the studies included in the review reported that the likelihood of achieving a pregnancy was lower for women who were aged over 40, had a body mass index over 25 (using weight divided by height squared) and were smokers. Arising from these findings from the review the authors conclude that '…Based on the evidence reviewed, it may be appropriate to consider incorporating eligibility criteria around maternal age and obesity in public funding policies in Canada and internationally to optimize

the safety and effectiveness of in vitro fertilization and reduce costs associated with complications and ineffective treatment cycles. To determine the appropriate [age] cut-off points, further research and a discussion around acceptable levels of clinical effectiveness are needed…' p432.[30] This work by Menon and colleagues is the most up-to-date review that we located which examined the evidence for including an upper female age limit, an upper BMI level and a patient's smoking status in criteria for the public funding of assisted reproductive technologies. The key message arising from this review suggests that additional empirical evidence is needed to reach clinical consensus on cut-off points for upper age limits; the rationale for pursuing further evidence is to optimise the safety and effectiveness of IVF and reduce costs associated with adverse outcomes. Of note, in New Zealand cut offs are considered on the basis of ovarian reserve.

More recent evidence to appear from a study in Canada endorses the findings by Menon and colleagues on the need for policy-makers to consider including an upper female age limit as part of criteria for accessing publicly funded assisted reproductive technologies treatment. Ouhilal *et al*. undertook a retrospective analysis of data from a cohort of women aged over 40 years who received publicly funded in vitro fertilization treatment in Quebec between August 2010 and December 2012. There was no upper age limit attached to the criteria for receiving funding. Ouhilal and colleagues examined the outcomes in terms of live births and the costs of treatment for this cohort. The number of live births per cycle declined from 105 (10%) at age 40 years, to 69 (6.9%) at age 41 years, to 51 (5.4%) at age 42 years, to 20 (4.1%) at age 43 years and to zero (0.0%) births at age 44 years. The data also showed that the mean cost of publicly funding a live birth increased from Can$43,153 for a 40-year-old woman to Can$103,994 for a woman aged 43 years; the mean cost of funding per woman aged 44 years was Can$597,800 and none of these older woman had a live birth. The authors conclude that '…For women over the age of 40, live birth rates are low and come at a substantial financial cost in a public program. Age eligibility criteria should be considered by any government planning to introduce public funding [of assisted reproductive technologies]…' p298.[85]

According to Guzick '…the concept of fecundability refers to the probability of pregnancy during a given menstrual cycle. This is the metric most appropriately used to study a trend in the biological capacity of women to conceive as they progress through their reproductive years…' p1461.[97] In a more recent study, Steiner and Jukic [98]estimated the decline of fecundability in a cohort of women as they progressed through their 30s and 40s. Steiner and Jukic report that, compared with a base pregnancy rate per cycle of 20% at age 30–31 years, pregnancy rates decline steadily, beginning at age 34–35 years (rate needed), with average rates of 13.2% at age 38–39 years and 6.6% at age 42-44 years.

However, there are some additional age-related ideas identified in the studies reviewed that are also used to support the inclusion of an upper female age limit in criteria for accessing public funding for assisted reproductive technologies. For example, Mladovsky and Sorenson point out that there is an argument that '…infertility can result in a medical need, because it can be a disruption of normal species function and can result in diminished opportunity, which is highly relevant to the conception of a good life for many people…' p119.[32] The

normal species function relates to the 'reproductive age' where fertility may be considered the normal expectation and infertility may be considered a deviation from the norm.

For example, according to Carter and Braunack-Mayer '…as part of their rationale for limiting public funding for assisted reproductive technologies to women aged 37 years and under, the Southern Health Care region of Sweden cites 'a normal-deviant' scale. This implies that infertility in older women represents less of a deviation from the norm than infertility in younger women and that, as such, older women have less need for assisted reproductive technologies. This implicitly conceives of medicine as properly limiting itself to the correction of (burdensome) deviations from the norm…' p464.[50]

The paper by Carter and Braunack-Mayer[50] is a philosophical discussion centered on the appeals to nature that are often implicit in some restrictions on public funding for assisted reproductive technologies. However, their interpretation of using the normal-deviant scale to set criteria for public funding of assisted reproductive technologies differs somewhat from that offered by Mladovsky and Sorenson[32] who appear to argue that infertility in general can be considered a deviation from normal functioning, not just infertility confined to younger women of 'reproductive age' where fertility may be considered the normal expectation. Nonetheless, the points raised by Carter and Braunack-Mayer give some further credence to the consideration that assisted reproductive technologies may be considered a medical need and therefore may warrant inclusion in the basket of publicly funded healthcare goods. For example, they argue that '…appeals to nature, in particular those often moderating the provision and public funding of assisted reproductive technologies, are at the very least intelligible and defensible… In debate – over access to treatment and funding, for instance – some deference to nature cannot conscionably be dismissed in principle. It must be considered on its merits in the particular case. Some deference to nature may simply give us pause or affect the spirit in which we do choose to defy nature (say, in the service of others)' p467–470.[50]

It would appear that sections of the public and clinicians who provide assisted reproductive technologies treatment are undecided on the issue of attaching specific upper female age limits to the public funding. For example, Hodgetts and colleagues report on the views of assisted reproductive technologies consumers, clinicians and community members in Australia.[25] Primary data were collected via two rounds of deliberative engagements with groups of assisted reproductive technologies consumers, clinicians and community members; discussions were transcribed and a thematic analysis of the data was undertaken. Participants in the consumer forums were purposively recruited on the basis of their experience of undergoing assisted reproductive technologies; nine attended Round 1 and seven returned in Round 2. Community forum participants were randomly sampled and 14 attended Round 1 and 10 returned for Round 2. Clinician participants were purposively recruited on the basis of relevant technical experience and as nominees from relevant medical bodies; eight attended Round 1 and six returned for Round 2.

The forums reported on by Hodgetts *et al*.[25] were structured around the provision of information to support participants' deliberation on the question of how best to structure the public funding of assisted reproductive technologies in Australia.

There was broad agreement from the consumer and community groups that some upper female age limit should be applied as criteria for access to public funding for assisted reproductive technologies; however, both groups were quite liberal with their proposals. For example, '…The consumer forum agreed to outer female age limits for assisted reproductive technologies subsidies: no access under 21 or over 45…' p5. In addition, '…Participants in the community forum agreed on an upper age limit of 45 years and a lower age limit of 18 years for subsidized assisted reproductive technologies…' p7. The clinicians' view differed from that of the consumer and community groups, as clinicians '…rejected calls for blanket age or cycle limits. However, there was agreement that ovarian age would represent a more legitimate basis for restrictions than chronological age, if limitations were deemed necessary… concern around discrimination (specifically framed in terms of unequal access to significant, life-changing technology) underpinned deliberations…' p8–9. Clinicians strongly expressed their objections to setting upper age limits on the grounds that they would be blamed for discriminating against people on the basis of their age.

The consumer group echoed the views of clinicians that ovarian reserves in the woman would serve as a more useful indicator of fertility than a blanket age cut-off point. According to Hodgetts *et al*.[25], '…Ultimately, the consumer forum reached its strongest agreement around the notion that ovarian reserve (in conjunction with other physiological markers of likely treatment effectiveness) is the most appropriate basis for limiting subsidy, and is preferable to limits based upon age or cycle number. This agreement was underpinned by the understanding that such policy decisions should be both "individualised" and "grounded in medical evidence"…' p5. The community group also expressed a preference for decisions to be left to the clinical encounter between patients and clinicians. In their deliberation, '…More restrictive limits on the basis of maternal age and number of cycles generated considerable debate, a pervasive perspective being that treatment decisions should be "individualised" rather than being based upon population statistics…' p7.

The ideas expressed by all three groups appear to be more supportive of the idea that women should be assessed on their capacity to benefit from assisted reproductive technologies, rather than be subjected to an arbitrary upper age cut-off point. This means that information on their ovarian reserves in addition to other health markers and their age should be considered by patient and clinician in the clinical encounter. According to Hodgetts and colleagues, women in the consumer group illustrated this viewpoint quite well, '…While essentially representing a "capacity to benefit" argument ("the ability of a person to have a baby"), such accounts called for more nuanced restrictions than blunter, age-based limitations. However, although these arguments appeared to place considerable decision-making responsibility in the hands of clinicians, participants were keen to hold doctors' powers in check…' p5.[25]

The age-related question that concerned many of the participants across the three forums highlighted above also concerns Carter and colleagues in their theoretical paper which asks the question 'Should there be a female age limit on public funding for assisted reproductive technologies?'[51] Carter *et al*. also raise the issue of the capacity to benefit as one of the underlying principles that should underpin the allocations of public resources to fund

assisted reproductive technologies. The authors draw on a mix of published and unpublished sources, including empirical quantitative data. The analysis is based on an exploration of arguments for and against a female age limit with reference to three substantive principles of justice, namely the capacity to benefit, personal responsibility, and need.

Carter *et al.*[51] examine the different policies of Australia, New Zealand, and the Southern Health Care Region of Sweden to demonstrate how these three assisted reproductive technology funding policies incorporate the three principles of justice across a number of criteria that claims for public funding for assisted reproductive technologies must either meet or be prioritized against. In particular, they focus on how female age is considered relevant or not to the allocation of public funding for assisted reproductive technologies.

For example, they argue that '…Australian assisted reproductive technologies funding policy features no reference to female age. Nowhere is the capacity to benefit from assisted reproductive technologies referenced. Implicitly, then, that capacity is either neglected, actively rejected as irrelevant, or accommodated within the view that assisted reproductive technologies is always worthy of funding on grounds of allocative efficiency… Australian assisted reproductive technologies funding varies neither with a person's capacity to benefit nor with one's degree of need. All women are implicitly accepted as equally in need, provided that they or their male partner are medically infertile…' p87.[51] Australia is credited with providing quite generous public subsidy for assisted reproductive technologies services.[51, 18, 23, 25, 42, 43]

In contrast to Australia's policy, New Zealand includes female age limits due to the link with cost-effectiveness. Since 2000, New Zealand has used the Clinical Priority Access Criteria to score a person's claim on assisted reproductive technologies public funding. The criteria include: chance of pregnancy without treatment (or 'diagnosis'); female age; duration of infertility; number of children; and sterilization status.[20] Only applications that reach the threshold score of 65 receive funding, which covers a maximum of two treatment cycles. According to Carter *et al.,* '…The sole criterion of female age is used to estimate and correspondingly score the probability of treatment success (listed as pregnancy, not a live birth). In calculating the strength of claims on assisted reproductive technologies public funding, women are allocated point-multipliers of 1.0, 0.5, or 0.1 if their age is less than or equal to 39, 40–41 years, or greater than or equal to 42 years, respectively. Theoretically, then, a 39-year-old woman is 10 times more likely to receive public funding for assisted reproductive technologies than her 42-year-old counterpart…' p88.[51]

However, it would appear that the introduction of the female age limit in New Zealand was not without its opponents. According to Gillett *et al.*, '…The age criterion was the only criterion that caused considerable disquiet in the public submissions that preceded the introduction of the CPAC. The main argument was that older women had the most urgent need…' p139.[20]

The argument in the literature that older women have the most urgent need for assisted reproductive technologies is often linked with the claim, that although statistically small, they also retain the capacity to benefit from assisted reproductive technologies on the

grounds that some older women do give birth when treatment is administered. However, it would appear that the capacity to benefit argument does not hold currency in New Zealand as it is deemed not to be cost-effective to fund women aged over 40 years. As pointed out by Carter *et al.*, '…the New Zealand scoring system, with what functions as an age limit, implicitly accepts the argument that, by virtue of their reduced capacity to benefit by assisted reproductive technologies, older women use assisted reproductive technologies resources at too great an opportunity cost, i.e., those same resources might benefit other (younger) women more. Implicit in the funding threshold of 65 points is also a rejection of the argument that the capacity of older women to benefit by assisted reproductive technologies is, although less than that of younger women, nonetheless sufficient to justify expenditure in view of its cost-effectiveness relative to other forms of healthcare…' p88.[51] However, notwithstanding the criticism of the New Zealand scoring system, it could be argued that it has the potential to provide a transparent and accountable system to allocating public resources towards the funding of assisted reproductive technologies. For example, Gillett and colleagues point to what they consider one of the strengths of the system – its flexibility '…The New Zealand Clinical Priority Access Criteria allows incremental changes in funding (up or down) without needing to change the scoring system or criteria. We [Gillett *et al.*] contend that using a score such as ours is much easier to administer…' p138.[20]

The National Institute for Health Care and Clinical Excellence has included revised upper age limits for women seeking funding for IVF in the UK.[99] In women aged under 40 years who have not conceived after two years of regular unprotected intercourse or 12 cycles of artificial insemination (where six or more are by intrauterine insemination), three cycles of in vitro fertilization are offered, with or without intracytoplasmic sperm injection. If the woman reaches the age of 40 during treatment, it is recommended to complete the full cycle with no offer of funding for further cycles. In women aged 40–42 years who have not conceived after two years of regular unprotected intercourse or 12 cycles of artificial insemination (where six or more are by intrauterine insemination), public funding for one full cycle of in vitro fertilization is provided as long as they have never previously had in vitro fertilization treatment. The recommendation to fund one full cycle of in vitro fertilization treatment for women aged 40–42 years was based on clinical opinion and reflected the improvements in in vitro fertilization treatment since the previous NICE guidelines in 2004, which set the upper age limit at age 40 years. Following input by clinicians and public consultations, '…it was concluded that ovarian reserve testing could be used as the basis for a recommendation to offer in vitro fertilization in this age group 40–42 years where falling ovarian reserve was the commonest cause of infertility. This would mean offering in vitro fertilization to women with a demonstrable chance of success…' p262.[100]

Finally, it is reported that most countries that provide public funding for assisted reproductive technologies include an upper age limit as part of the criteria to access public funding.[36, 3, 16] It is also reported that as women age their fertility rate declines at a steady pace and that by the time a woman is 40, she has only a 10% chance of achieving a live birth, and cost to the public purse from funding women aged 40 years and over is excessive, with steep increases arising in overall cost between 42 and 45 years.[85, 30, 98]

Nonetheless, it is the case that discussion around setting upper age limits for women accessing public funding for assisted reproductive technologies remains divided, and in some cases, it remains peripheral. Age is sometimes used as the default criteria, included in the assisted reproductive technologies-related policies of nation states without evidence of explicit discussion. For example, Klemetti and colleagues provide a useful illustration of this apparent unease with discussing age from a study in Finland: '… As in other countries, prioritizing has been indirectly discussed in Finland: should infertility be considered a disease or not, should treatments be given only for medical reasons (diagnosed medical infertile) or also for social reasons, and who should have the right to treatments or eligibility? Prioritization has not, however, been discussed explicitly, even though in vitro fertilization is clearly prioritized by women's age…' p215.[27]

5.4.1.2 Medical indication and the status of infertility as a disease or medical condition

According to Mladovsky and Sorenson '… Under this rationale, any woman who is medically infertile would be eligible for reimbursement regardless of other demographic, social or economic circumstances…' p117.[32] However, they also point out that '… the definition of infertility is far from clear. It has been argued that infertility is not a disease, but… rather a symptom of a possible underlying disease…' p117. Further problems with defining infertility as a disease arise because '… the term 'infertility' covers a range of disorders, from sterility to possibly normal fertility if the period of non-conception used to define infertility is short in duration… [Additionally] there is also no clear distinction between the terms 'subfertility' and 'infertility…' p117.[32]

What seems to happen in practice is that involuntary infertility is often diagnosed and defined when a period of time of active sexual intercourse has elapsed without conception occurring. However, there are also problems with this attempt to reach a definition. According to Mladovsky and Sorenson, '… It is not clear how long involuntary failure to conceive must continue before 'infertility' is attributable; in the clinical context, a threshold of a one-year period has become the norm, while in epidemiological studies, a two-year period is the standard…' p117.[32] Nonetheless, the threshold of one year of active sexual intercourse is generally used in the clinical context to define infertility and can be seen as a pragmatic attempt to promote clinical consensus in a highly contentious arena of disputed definitions.

For example, a recent systematic review undertaken by Gurunath and colleagues to determine how infertility has been defined in prevalence studies underscores the contentious nature of defining infertility. Gurunath and colleagues noted the heterogeneity of criteria used to define infertility in the 39 articles they reviewed; in particular, they noted the key differences between demographic and epidemiological definitions. For example, demographers define infertility as childlessness, i.e. the absence of a live birth in a population of women of reproductive age, whereas the epidemiological definition is based on the woman 'trying for' or 'time to' a pregnancy, in a population of women exposed to the risk of conception. There is variation in the duration of 'trying for' a pregnancy, the age of the women sampled and their marriage or cohabitation status. Gurunath *et al.* point out

that while the demographic definition may be useful to use in large population studies that seek to identify infertility trends, it is not fit for purpose in a clinical setting when clinicians need to identify couples that are displaying difficulty in conceiving and perhaps could benefit from treatment. Gurunath *et al.* acknowledge the division of thought between clinicians and researchers, and regarding the lack of consensus on defining infertility, and they conclude further that '… for researchers and clinicians '… Infertility is a state ranging from near normal fecundity to an absolute inability to conceive. This breadth makes it debatable whether a single term can meaningfully cover the entire spectrum of the conditions…' p585.[101]

Nonetheless, and despite the heterogeneity surrounding the definition of infertility reported in the literature, seven of 13 European Union countries applied the criteria of 'medical indication' to their access for public funding for assisted reproductive technologies and four of these permitted the use of in vitro fertilization to avoid the transmission of serious diseases in 2008.[3] Austria, Germany and Italy limit treatment to diagnosed infertility in 2008. Please see Question 3 for the most recent published data.

In some countries, such as France, a medical diagnosis of infertility is sometimes accompanied by social criteria. For example, according to Berg Brigham *et al*. '… in vitro fertilization in France is regulated pursuant to its bioethics law, which insists that a couple's infertility be pathological in nature and medically diagnosed…' p667.[3] France has been providing full coverage public funding for assisted reproductive technologies since 2000.[16] However, the requirement in France for pathological infertility to be diagnosed prior to accessing publicly funded assisted reproductive technologies does not appear to be the sole criterion applied. According to Berg Brigham and colleagues '… The [French Bioethics] law incorporates social eligibility criteria as it describes the 'man and woman making up the couple', thereby excluding single women and men and homosexual couples regardless of pathology…' p667.[3] This observation by Berg Brigham and colleagues is also implied in the work of Gurunath *et al.* insofar that in both definitions of fertility identified in the published literature and used by researchers and clinicians, women must be sexually active to achieve a live birth (demographers) or engaged in regular unprotected sexual intercourse to achieve, or fail to achieve, a pregnancy (epidemiologists); both of these requirements have implications for the case for lesbian and single women and their access to publicly funded assisted reproductive technologies treatment.

Despite the heterogeneity surrounding the definition of infertility, there appears to be a continued willingness in most jurisdictions to require the diagnosis of infertility as a medical condition to access public funding for assisted reproductive technologies. This requirement may be explained by the observation of Gurunath *et al.* who argue that in a clinical setting when clinicians need to identify couples who are displaying difficulty in conceiving, perhaps the epidemiological time-based definition of the woman 'trying for' a pregnancy for at least one year is perhaps more practical and fit for purpose.[101] However, there are additional factors to the clinically pragmatic argument that need to be considered which could equally explain why some countries include a medical diagnosis of infertility as part of criteria for accessing publicly funded assisted reproductive technologies. For example, according to Berg Brigham *et al*. '… In terms of eligibility, both medical diagnosis requirements and age limits may be more narrowly defined for publicly financed in vitro fertilization, with the

ostensible justification of limiting expenditure of public health-care resources to those with demonstrated medical needs and statistically better chances for success…' p668.[3]

It would appear the case that policy-makers are not helped by the continuing division of thought between clinicians and academics about defining infertility. In a study that surveyed national stakeholders in the assisted reproductive technologies arena, respondents linked the limited public funding for assisted reproductive technologies with the questions around defining infertility as an illness. According to Connolly *et al*. '… Public funding challenges for assisted reproductive technology are not new, with only six of 57 countries surveyed [in 2010] providing fully funded treatments. Explanations for limited funds for assisted reproduction include the perception of Infertility as a low health priority and the questioning of infertility as an illness within the wider healthcare framework…' p831.[12]

5.4.1.3 Adherence to embryo transfer limit restrictions as criteria to access public funding

In some countries, the number of embryos transferred per attempt are legally restricted or voluntarily agreed in public funding programmes for assisted reproductive technologies. In most of these countries, the rationale for restricting embryo transfers is to reduce multiple births, which are often linked to health risks and high costs. Question 3 presents country policy on assisted reproductive technologies. According to Dunn and colleagues, '…the rationale for assisted reproductive technologies policy in most jurisdictions states a goal of improving health outcomes [i.e. reducing multiple births and reducing negative health outcomes for mother and babies], as opposed to a desire to control costs or reduce treatment or pregnancy-related service utilization…' p263.[16]

So, what is the evidence base for some countries insisting that patients adhere to restrictions on the numbers of embryos transferred as part criteria for accessing public funding for assisted reproductive technologies?

In a systematic review published in 2010, McLernon *et al*. compared the effectiveness of single-embryo transfer versus double-embryo transfer on the outcomes of live birth, multiple live birth, miscarriage, preterm birth, term singleton birth, and low birth weight after fresh embryo transfer, and on the outcomes of cumulative live births and multiple live births after a combination of fresh and frozen embryo transfers.[102] McLernon and colleagues included eight eligible randomised control trials in their meta-analysis; the trials comprised 683 and 684 women randomised to the single- and double-embryo transfer arms, respectively. The baseline characteristics in the two groups were comparable. The authors report that the overall live birth rate for a fresh in vitro fertilization cycle was 27% after a single-embryo transfer compared to 42% in the double-embryo transfer. The multiple birth rates were 2% for single-embryo transfer compared with 29% for double-embryo transfer. An additional frozen single-embryo transfer, however, resulted in a cumulative live birth rate of 38%, which was not significantly lower than the rate after one fresh double-embryo transfer (42%), and achieved with a lower proportion of multiple births (single-embryo transfer group 1/132 (1%) versus double-embryo transfer 47/149 (32%)). The odds of delivering a full-term (i.e., delivery after 37 weeks gestation) singleton birth after elective

single-embryo transfer was almost five times higher than the odds of a term birth after double-embryo transfer. However, the authors of this review do warn that '… nearly all [included] trials focused on [young] women with a good prognosis so our findings are not generalizable beyond this group…' p10.[102]

Some patients may prefer to have double-embryo transfer due to the improved chances of a live birth that transferring more than one embryo can achieve. The review by McLernon *et al*. confirms this outcome, but the authors also highlight a clinical procedure that can help to bypass the preference for double-embryo transfer. According to McLernon *et al*. '…This study confirms earlier results from aggregated systematic reviews that in a fresh in vitro fertilization treatment cycle, elective single-embryo transfer is associated with a reduced chance of live birth compared with double-embryo transfer, but that the additional transfer of another frozen single embryo in a successive attempt but as part of the same cycle results in a comparable live birth rate and virtually eliminates the risk of twins…' p10.[102]

In a paper by the Practice Committee of the Society for Assisted Reproductive Technology and Practice Committee of the American Society for Reproductive Medicine, the authors acknowledge the challenges that exist to the implementation of single-embryo transfer. The authors say that provider and patient education may go some way to informing both parties about the risks and costs involved in multiple-embryo transfers and the advancements in assisted reproductive technologies around using cryopreservation to freeze embryos that can be transferred in subsequent attempts. They also acknowledge that '…reduced financial burdens for in vitro fertilization through insurance coverage or risk-sharing schemes have been shown to improve patient's acceptance of single-embryo transfer…' p839[103]

5.4.1.4 Body mass index and smoking tobacco products as criteria to access public funding

New Zealand, England, Scotland and Wales include BMI in their criteria for accessing in vitro fertilization or intracytoplasmic sperm injection. In New Zealand, women must have a BMI rate of less than 32 and for those who are over this level, they are encouraged to enter a weight improvement programme and are kept under active review until they achieve a lower BMI rate. There is evidence to suggest that including a patient's BMI level in their assessment for access to assisted reproductive technology treatment is a legitimate course of action. For example, Rittenberg *et al*. undertook a systematic review of the literature to evaluate the effect of raised BMI on treatment outcomes following treatment with in vitro fertilization or intracytoplasmic sperm injection, and they included 33 studies in their meta-analysis. Women with a BMI over 25 had lower clinical pregnancy and live birth rates and a higher rate of miscarriage compared with women who had a BMI of less than 25. The authors also distinguish between the effects on obese and overweight women and note that '…the poorer outcomes of in vitro fertilization treatment is not limited to women with a BMI of more than 30 [obese women], overweight women with a BMI of 25–29 also have significantly lower pregnancy and live birth rates and higher miscarriage rates after in vitro fertilization treatment compared with women with a normal BMI…' p435.[104] New Zealand, England, Scotland and Wales require that patients accessing assisted reproductive technology treatment have not been smoking for at least three months prior to treatment.

New Zealand provides documented evidence of providing support for patients who smoke through encouraging them to engage with a smoking cessation programme. There is evidence to support the case for including a non-smoking status on patients who access assisted reproductive technology treatment for infertility and for supporting those who smoke to cease this behavior. Waylen *et al*. undertook a systematic review of the published literature to examine the effects of cigarette smoking on clinical outcomes of patients who were treated with assisted reproductive technologies; they included 21 studies in their meta-analysis. Compared with non-smokers, women who were smokers at the time of treatment had a lower live birth rate per cycle, a decreased clinical pregnancy rate and a higher rate of miscarriage and ectopic pregnancy. The authors conclude that '…In order to improve success rates for assisted reproductive technologies, this evidence should be presented to actively smoking women seeking treatment for infertility, along with strong advice to cease smoking…' p43.[105]

In a recent systematic review by Menon and colleagues, the evidence for including a BMI level and smoking status in addition to an upper female age limit is examined and despite some limitations in the robustness of the evidence, the authors conclude that setting an upper BMI rate in addition to an upper female age should be considered by policy-makers as part of the criteria to access funding for assisted reproductive technologies.[30] The rationale for and evidence of the cost-effectiveness of assisted reproductive technologies is presented in Question 2.

5.4.1.5 Rationale for using public funding to reduce the demographic deficit

A number of authors have claimed that demographics may be an influential factor in a state's decision to subsidize the provision of assisted reproductive technologies.[33, 32, 37, 1, 4, 10] However, only a small number of states that provide public funding for assisted reproductive technologies make explicit reference to demographics being linked to their policy decision on public funding for assisted reproductive technologies. For example, Mladovsky and Sorenson reported that '…The only countries to reimburse in vitro fertilization with the explicit aim of increasing fertility [are] Korea and Estonia…' p123,[32] and Connolly and colleagues report that '…In countries with birth rates below replacement level [such as Sweden], one interpretation may be that funding in vitro fertilization represents a good use of public resources with likely economic rewards in the future. In fact, such conclusions have recently been taken in Korea and Sweden, where increased public funding was made available because of low birth rates in these countries…' p630.[10] Nonetheless, despite the absence of explicit accounts of linking the funding of assisted reproductive technologies with demographics, there are some reports that this linkage is being made in Europe. According to Simonstein, '…the social acceptance of in vitro fertilization has had the effect of shifting the focus of discussion from the earlier disapproval of in vitro fertilization to its availability. It has been suggested that affordable assisted reproductive technologies may stop the falling rates of population turnover in Europe…' p202.[37] Indeed, given that the use of assisted reproductive technologies as a viable treatment for infertility is now almost a universal social norm, persuading the public to fund access to assisted reproductive technologies to address demographic deficits may be acceptable to the electorate.

According to Connolly *et al*. '…Given the importance of birth rates for achieving generational balance described earlier, it is possible to imagine how the benefits of assisted reproductive technologies may extend beyond the benefits conferred on the parents and offer a broader benefit to society…' p627.[10]

Rates of global infertility appear to differ from national and regional rates. According to Agarwal *et al*. in a recent paper, '…Infertility is a worldwide problem, and affects 15% of couples that have unprotected intercourse. Although this statistic is commonly cited, it is an amalgamation of numbers taken from around the world and thus does not reflect rates in specific countries and regions…' p1.[106]

However, whether rates of infertility are increasing across the globe is not clear according to a 2012 review by Mascarenhas *et al.* in which the authors calculated primary and secondary infertility rates from 27 survey datasets in 190 countries, most of which were nationally representative. They used a demographic infertility measure with live birth as the outcome and a five-year exposure period based on union status, contraceptive use and desire for a child. They estimated that '…Between 1990 and 2010, levels of primary and secondary infertility changed little in most world regions… However, the absolute number of infertile couples increased due to population growth…' p9.[107]

Mascarenhas and colleagues provide a useful summary of a broad set of factors that are seen to comprise infertility and the impact of these factors on our understanding of infertility. According to Mascarenhas *et al.*, '…Multiple factors—infectious, environmental, genetic, and even dietary in origin—can contribute to infertility. These factors may affect the female, the male, or both partners in a union, resulting in an inability to become pregnant or carry a child to term. Current evidence, mostly from clinical studies with few exceptions, indicates that differences in the incidence and prevalence of infectious diseases, leading to fallopian tube blockage in women, are the main reason for changes over time and differences between populations. Some have hypothesized that sperm quality is declining, but the evidence is not conclusive. Increasing age at childbearing could also increase the prevalence of infertility, as the ability to become pregnant and deliver a live birth reduces with age in all populations. Globally, the mean age at childbearing has remained the same (about 28 years) since the 1970s, although this masks regional and temporal heterogeneity in trends…' p9–10.[107]

Some authors have argued that Israel is a good case in point where assisted reproductive technologies policy is heavily influenced by the demographic case. For example, Simonstein tells us that '…Due to budgetary constraints in 1998, the Ministry of Health in Israel proposed limiting the provision of in vitro fertilization to six cycles per woman…' p205.[37] Subsequently the proposal was discussed in the Knesset, the Israeli house of parliament, and arising from this discussion and its coverage, it was identified that '…there were three narratives to account for the state's in vitro fertilization policy: a nationalised narrative of reproductive medicine as a source of international acclaim; a personalised narrative of compassion for anguished women; and a medicalised narrative of experts who are most capable of regulating in vitro fertilization…' p205.[37]

Drawing on a published analysis of the discussion that took place in the Knesset, Simonstein goes on to point out that it was also felt that implicit in the arguments to maintain the status quo of publicly funding unlimited cycles of assisted reproductive technology treatments was the state's interest in enlarging its Jewish population; '…it was the demographic interest that enabled the various participants of the committee to present a unanimous agreement. The state then used this consensus as a "firm" civil ground for the maintenance of Israel's assisted reproductive technologies policy…' p205.[37]

Balabanova and Simonstein appear to be in agreement about Israel using generous public funding for assisted reproductive technologies to bolster the state's demographic plans; they claim that '… in Israel the public sphere is filled with discussions of demographic problems (legacy of Holocaust) and any action to address this is seen as appropriate. Reproductive policy in this country has been presented as the state's concern for women's rights to become mothers; yet since other women's rights are inexistent (i.e. abortion) the right to motherhood becomes a convenient cover-up for a policy that in fact aims at increasing natality for demographic reasons… in Israel the state uses women's bodies promoting in vitro fertilization for demographic purposes…' p200.[1] The paper by Balabanova and Simonstein is a comparative review of in vitro fertilization policies in Israel and Bulgaria. The authors draw on data from a selection of published studies and some modest secondary data analysis to criticize Israeli policy for promoting the notion that Jewish women need to persevere with in vitro fertilization until they conceive. They point to data showing that the majority of women undergoing in vitro fertilization treatment in Israel fail to conceive, even after many attempts, and how the state fails to prepare women for the adverse implications of undergoing many cycles of treatment. According to the report on the experiences of women who had failed to conceive after many attempts with in vitro fertilization:[1]

> '…Women found themselves after many years of in vitro fertilization treatment without a child but also disfigured (overweight because of the hormonal shots), their partnerships lost to the stress and lack of sexual intimacy, and their careers ruined by the time spent feeling sick because of the treatment. In other words, many women after years of in vitro fertilization treatment end up worse off…' p197.

Following on in this critical vein, Birenbaum-Carmeli presents a critical analysis of state policy in Israel around assisted reproductive technologies and includes data collected from open-ended interviews with the directors of the six major hospital-based sperm banks in Israel. In her analysis, Birenbaum-Carmeli endorses the view of assisted reproductive technologies policy in Israel pursuing the demographic case, stating that '…From its early days, local politicians supported in vitro fertilization, which they viewed as a means to increase the country's Jewish population. In its first years, treatment was funded by the Prime Minister's office…One explanation for the politicians' stance is the state's demographic interest in Jewish expansion' p1020.[4] Birenbaum-Carmeli goes further in her analysis and points out that not only is state policy in Israel on public funding for assisted reproductive technologies heavily influenced by the demographic case and inherent claims to promote the notion of motherhood as a right, but also that there are grounds to believe that the policy promotes an idealized vision of the Jewish family as the natural genetic unit of Jewish race reproduction. According to Birenbaum-Carmeli, '…The preference of an

intrusive treatment, even when ineffective and potentially harmful, over safer and "guaranteed", although less "biogenetic" alternatives to parenthood suggests a hierarchy. It suggests that beyond subscribing to the Jewish-Zionist discourse of motherhood as a basis for a woman's normalcy and place in society, Israeli in vitro fertilization patients accept the primacy of biogenetic motherhood. From the extensive public investment in procreative medicine, infertility emerges as such an injury to both the individual and the collectivity that its alleviation apparently calls for any investment of energy, time and if inevitable, also money, as recently embodied in Israelis' travels abroad for donor ova…' p1022.[4] Birenbaum-Carmeli questions why Israel has tight restrictions on domestic adoption and a complete lack of state support or subsidy for inter-country adoption, given that adoption is a more effective and less risky way to become a parent compared to the practice of using assisted reproductive technologies.

However, proposals to use publicly funded assisted reproductive technologies to address demographic deficits are not without other critics. For example, Mladovsky and Sorenson caution that '…the idea that publicly funded in vitro fertilization could redress population ageing in a cost-effective manner needs to be treated with caution, not least because there is very little experience with it and minimal supporting evidence…' p123.[32] Indeed, Mladovsky and Sorenson go further than claiming that assisted reproductive technologies may not be a cost-effective way to redress population ageing; they also warn that accelerating assisted reproduction to increase fertility rates to address population decline '…may lead directly or indirectly to the exploitation of women, commodification of gametes and embryos, compromised safety of in vitro fertilization services, and unethical practices of clients…' p125.[32]

Perhaps the main obstacle to states openly admitting that their policies on assisted reproductive technologies funding is influenced by their concerns with changing demographics is the likely questions on cost-effectiveness that may arise. For example, according to Mladovsky and Sorenson, '… Reimbursement decisions based purely on a population-level framework would mean that typical eligibility requirements (e.g., age, being subfertile, married or childless) may no longer apply…' p123.[32] This may have implications for putting some checks on who accesses funding; for example, we know from Canada that the absence of a female upper age limit led to an increase in the projected funding figures which caused the programme to be reappraised.

5.4.1.6 Social and political concerns as part of the rationale for publicly funding

It would appear that the bulk of evidence used to justify the selection of criteria for public funding comes from the economic and clinical literature. However, policy-makers rarely rely solely on these two strands of evidence when making decisions on public funding for assisted reproductive technologies and its associated access criteria. Some authors have identified additional influences that can shape decisions on public funding for assisted reproductive technologies and its related access criteria. For example, Mladovsky and Sorenson provide a summary of the many influences that can weigh on a decision: '… while clinical and economic considerations are likely to remain central to decision-making…they

cannot be easily detangled from social, political, ethical, and even philosophical dimensions…[and} while the rationales for public funding…are often divergent, contradictory, overlapping, and inconclusive, taken together they provide guideposts which signal important issues for consideration…' p124.[32]

Berg Brigham and colleagues suggest that it is the unique characteristics of assisted reproductive technologies that encourage the consideration of influences beyond the economic and clinical considerations that can play a role in policy decisions. According to Berg Brigham *et al*., '… As a health-care good among others in the benefits basket, in vitro fertilization occupies a unique place subject to a range of characterizations – from discretionary good [in some countries] to fundamental human right [in other countries] – that affects how it is regulated. Beyond the clinical and economic considerations that generally affect access and coverage, decisions have complex social, historical and political dimensions that are sometimes cloaked in scientific and ethical concerns…' p667.[3]

On the other hand, Chambers and colleagues argue that decisions on funding and regulating assisted reproductive technologies are formulated in a similar way to decisions on other health goods: decisions are rarely fixed; they evolve in response to technological changes and sociocultural pressures and trends. The authors state that '…The regulation and financing of assisted reproductive technologies in developed countries share few general characteristics and continue to evolve in response to technologic advances, sociocultural pressures, and a trend to later childbearing. The cost and funding of assisted reproductive technologies are typical of the underlying healthcare systems in each of the countries reviewed, reflecting the varying degrees of public and private responsibility for purchasing healthcare and total healthcare expenditure…' p2291.[7]

Connolly and colleagues also pick up on the role of similar pressures and social trends that influence decisions made by policy-makers around the funding of assisted reproductive technologies. They point out that '… The past decade has witnessed increased demand for assisted reproductive technologies, of which in vitro fertilization is predominant. Increased demand is attributed to factors including increasing prevalence of infertility resulting from couples delaying time to first pregnancy, increasing obesity and an increased prevalence of sexually transmitted diseases, as well as an increased awareness of available infertility treatment options…' p627.[10]

Attempts to identify patterns and themes in the literature are hampered by the unique characteristics of individual countries. The papers that we have reviewed illustrate variety in public funding criteria in the policies of individual countries and in the main evidentiary and other national influences that are brought to bear in the setting of individual country criteria. According to Watt and colleagues in their review of assisted reproductive technologies funding policies in Australia, the UK, New Zealand, Canada and Israel, '… Each country has its own social, political and medical history of assisted reproductive technologies funding which has shaped resource allocation…' p201.[43]

Indeed, policy analysis of assisted reproductive technologies and public funding programmes is a challenging exercise. Dunn and colleagues encapsulate these challenges concisely in the following extract:

> '…policy development and implementation typically takes place in complex environments, where different views and conflicting perspectives often come into play. In the case of assisted reproductive technologies, understanding the determinants of specific policies and their effects are further complicated by conflicting values, religious beliefs and different views on the "medicalisation" of infertility. As a result, policy analysis of assisted reproductive technologies is challenging. Findings from studies must be interpreted with caution, since it is difficult to account for all factors influencing the impact of assisted reproductive technologies policies through most types of analyses. Further, in some countries, assisted reproductive technologies policies have become moving targets, seeing frequent changes over the last decade. Therefore, the policies actually being measured in studies may not be clear…' p261.[16]

The papers we have reviewed speak to a range of evidence and influences that make up the rationales for public policy decisions on public funding for assisted reproductive technologies. As we suggested in the introduction, national policies are a hybrid of political, cultural and economic pressure combined with science leading to a publicly acceptable or pragmatic approach to funding assisted reproductive technologies in each individual country. In one of the few papers we identified that explicitly discusses the nature of government rationales towards public funding for assisted reproductive technologies, Watt and colleagues highlight the experience in Australia, which they suggest could also be mirrored in other countries. They point out that:

> '…Mirroring the international experience, the public subsidy of assisted reproductive technologies has been a perennially contentious health policy issue in Australia. The Australian Government – regardless of the party in power at the time – has periodically entered into policy debates around access criteria for assisted reproductive technologies services. The use of clinical evidence in these policy debates has been highly variable; while some policy decisions have ostensibly been based on clinical evidence, others have claimed to be based on fiscal rationales and some appear to have been primarily politically motivated…' p201.[43]

5.4.1.7 Influence of lobby groups and political pressure

Watt *et al.* provide us with a useful insight into the role that lobby groups play in influencing policy decisions around the funding of assisted reproductive technologies. For example, they point out it was the political pressure exerted by lobby groups supporting in vitro fertilization that ensured an assisted reproductive technology subsidy was introduced in Australia, despite the contrary recommendation from the government review. According to Watt and colleagues, '…pro- in vitro fertilization lobby groups – coalitions of consumers and clinicians – successfully mobilized an electorally significant force of opinion for government funding of assisted reproductive technologies, and political pressure saw specific items for assisted reproductive technologies listed for public subsidy in 1990, with a lifetime limit of six stimulated cycles…' p201.[43] Subsequent lobbying in the years that followed appears to

have influenced further changes to the funding of assisted reproductive technologies treatment in Australia. As Watt *et al*[43]. point out, '…In 2000, the six-cycle limit was removed and replaced with an unlimited public subsidy [and the authors go on to say]…this, arguably, was a utilization reflected decision: very few women were undertaking more than six cycles of treatment, hence the removal of this restriction would have very little financial impact while hopefully silencing the vocal pro- in vitro fertilization lobby groups…' p201.[43]

Indeed, subsequent lobbying campaigns were at the fore in preventing the Australian Government from enforcing an upper female age limit, despite the presence of clinical evidence to back such a decision. In 2005 in Australia, a government-commissioned review of assisted reproductive technologies clinical outcomes recommended an upper age limit for treatment. The health minister proposed that women aged under 42 would be eligible for the public subsidy of three stimulated cycles per year and women aged 42 or over would be eligible for the subsidy of three stimulated cycles in total. According to Watt and colleagues, '…these limits reflected some of those in place in a number of European and other international jurisdictions, but were attacked by interest groups as discriminatory, potentially dangerous and stressful for women. The limits were not enacted and existing funding arrangements were maintained… In this instance, political considerations were clearly more influential than the clinical evidence-base and funding precedents set by other countries…' p201.[43]

In terms of considering the relative weight that countries may assign to different sources of evidence to justify their selection criteria for funding assisted reproductive technologies, it could be expected that a higher weighting would be accorded to clinical evidence given the health risks and costs associated with assisted reproductive technologies. However, this may not be the case in some jurisdictions where the influence of lobby groups in exerting political pressure appears to be prioritized. According to Watt *et al*., '… the policy history of public subsidy of assisted reproductive technologies in Australia is convoluted and inconsistent. What is clear, however, is that clinical evidence considering the safety and effectiveness of these technologies has rarely played an explicit role in the formulation of health policy in this domain. Fiscal and political pressures appear to be the key policy levers to date…' p202.[43]

However, not all lobby groups associated with assisted reproductive technologies appear to be able to exert the same level of influence in Australia. For example, attempts by clinician lobby groups to block the introduction of a cap on the Extended Medicare Safety Net for assisted reproductive technologies were unsuccessful in Australia. The 2009/2010 Budget introduced a cap on the amount of rebate claimable under the Extended Medicare Safety Net for assisted reproductive technologies in an attempt to limit the government's financial liability. The Extended Medicare Safety Net was designed to support patients with high out-of-pocket expenses. The cap was introduced when information became available indicating that the introduction of the Extended Medicare Safety Net was accompanied by an increase in demand for assisted reproductive technologies services. However, prior to 2010 the government's additional spending on assisted reproductive technologies through the Extended Medicare Safety Net had not been accompanied by a reduction in the out-of-pocket expenses of patients; rather, the information available indicated that the additional

spending was used to defray specialists increasing their fees. Clinical groups refuted the charge of increasing their fees but the cap was enacted in January 2010. According to Watt and colleagues, '… the capping of the Extended Medicare Safety Net did not attract the same level of [public] opprobrium seen in relation to proposed earlier reforms, possibly as it was not seen to discriminate against any particular sub-group of patients…' p202.[43]

It could be argued that what has been reported in Australia is unique to that setting and it is unlikely that similar influences could be brought to bear in other jurisdictions. On the other hand, as Watt and colleagues point out, '… the complex history of assisted reproductive technologies funding both in Australia and internationally contains reference to economic, social, moral and political factors as determinants of funding policy…' p202.[43]

5.4.2 Summary: Question 4

The published papers available for the review had scant focus on evidence-based rationales underpinning access criteria for publicly funded assisted reproductive technologies. In this section, we have outlined a number of inferences we have drawn from the papers reviewed to suggest that alongside clinical justifications, there were also economic, social and political concerns that play a part in a jurisdiction's justification for setting access criteria for public funding of assisted reproductive technologies. For example, most countries that provide public funding for assisted reproductive technologies included an upper age limit and/or a diagnosis of medical infertility (despite the lack of consensus on defining infertility) as part of the criteria to access funding. In addition a number of countries restrict the number of embryo transfers. However, there is clinical and ethical debate and discussion in the papers we reviewed on the topic of introducing a female upper age limit, and despite evidence to suggest that single embryo transfers are both cost-effective and a means of reducing health risks to mother and child, there is variation in the number of countries that adopt this criterion. Nonetheless, by focusing on the clinical and economic criteria outlined above, it can be inferred that the underlying rationale at work here is to optimise the safety and effectiveness of treatment by reducing multiple births and avoiding adverse health risks to mother and child, while exercising some measure of cost-control appears also to be a prominent concern in the papers reviewed.

Some authors suggest that in Estonia, Korea, Israel and Sweden, decisions to publicly fund assisted reproductive technologies are also influenced by a need to reduce the demographic deficit. We found evidence to suggest that this thinking was central to government decisions on public funding for assisted reproductive technologies in Israel. For example, it has been suggested that Israel's generous funding policy for assisted reproductive technologies is often associated with the state's pursuit of enlarging the Jewish population. Finally, a number of authors reported the influence of political lobbying, of socio-cultural concerns, attempts at fiscal restraint and delayed childbearing age, as important factors that weigh on the minds of policy makers when deciding to allocate public funding for assisted reproductive technologies. These social and political issues appear to play an equally important part to that of clinical concerns in some jurisdictions, for example in Australia. We conclude that national policies on public funding for assisted reproductive technologies are a hybrid of political, socio-cultural and economic factors often combined with clinical evidence

leading to a publically acceptable and pragmatic approach to funding in different jurisdictions. For example, commenting on funding policies in Australia, the UK, New Zealand, Canada and Israel, Watt and colleagues argue that '…Each country has its own social, political and medical history of assisted reproductive technologies funding which has shaped resource allocation…' p201.

6 Discussion and conclusion

This section will, firstly, summarize the nature of our work in compiling this evidence review. In doing so, we are going beyond a discussion on the strengths and limitations of the papers included in the review to discuss our approach and the decisions we took to undertake this work. Secondly, we present a summary overview of the main findings and key issues that we identified as relevant in the papers we reviewed to answer the four key questions. Finally, we provide our main conclusions based on the nature of the data that we collected and analysed and our interpretation of these data.

6.1 Strengths and limitations

For Questions 2 and 4, we relied primarily on peer-reviewed papers to provide data, with supplementary data provided by grey literature in the form of technical reports. For Questions 1 and 3, we relied mainly on grey literature, as it was more up to date, and we supplemented it with peer review literature. The papers included in this review were secured through a systematic search of MEDLINE and follow up on citations in publications, and supplemented with targeted searches of Google and Google Scholar and hand searches of relevant journals. We are confident that we retrieved sufficient papers to provide an up-to-date answer to the four questions posed; however, we acknowledge that we may have missed some papers as our search was comprehensive but not exhaustive.

The data extraction and analysis for Questions 1 and 3 were almost totally descriptive, i.e., we extracted verbatim sufficient data from the papers to describe the public funding mechanisms and their characteristics, and the criteria attached to these mechanisms. The data extraction and analysis for Questions 2 and 4 combined the verbatim extraction of data with some inferences made regarding relationships in the data. All our data extraction and analyses were guided by the four questions posed and we are confident we extracted sufficient up-to-date information to answer the questions. However, it may be the case that recent changes to funding policies in some jurisdictions may not have been captured in the English language literature available for review and we acknowledge this potential limitation.

We used a number of instruments matched to study design to appraise the quality of all the peer-reviewed papers and some of the grey literature. We selected two of these instruments on the basis of prior knowledge of their value as we had used both the systematic review appraisal instrument and the MMAT in previous reviews. We used a modified version of the economic evaluation instrument for the first time. We acknowledge that we used these instruments to describe the quality of all studies so that the data collected from them could be treated with caution or confidence rather than to include or exclude weak studies. The vast majority of papers we included were rated as high or moderate quality, which suggests that the data extracted can be trusted. However, we acknowledge that other authors may have used alternative quality appraisal instruments, which may have resulted in different ratings.

We have summarized data from relevant papers to answer each of the four questions posed, and we have made limited inferences from some papers to provide answers to some questions. Due to the nature of the questions and the diverse nature of the data collected from the included papers, it was not feasible to go beyond summarizing the data. For example, we were unable to integrate the data from the four questions to provide a synthesis of 'new findings'; the following are a number of reasons that prevented us from undertaking this exercise. Firstly, we extracted factual data from all sections of the papers we included, unlike a traditional synthesis which primarily relies on data reported in the 'findings' sections of papers; we used data from the introductions right through to the conclusions. In addition, we also extracted and used qualitative and quantitative data and some of these data were substantive and some were supportive. This meant that (i) it would have been difficult to trace epistemological links through the data as they derived from a plurality of disciplines, and (ii) the quantitative data used to answer Question 2 had little or no relationship to the data used to answer Question 1 and so on. Thus, we are confident that the diverse nature of the questions posed and the data used did not provide us with an opportunity to trace and establish relationships between the data, which prevented us from attempting a robust synthesis. This means that our synthesis is primarily a descriptive summary of the data with modest inferences where appropriate. However, we do acknowledge that other authors may disagree with our approach and suggest that it may be feasible to reframe Questions 3 and 4 to combine them in a more robust synthesis, or to reframe Question 2 to provide a more interpretative account of costs and benefits of public funding for assisted reproductive technologies. However, the Department of Health in Ireland, the primary user of this review, wanted descriptive factual data on individual countries rather than an overall academic synthesis.

6.2 Key findings

Having considered our approach to this work and the strengths and limitations of this approach, we now move on to provide a summary of what we identify as the main findings and issues to arise in our analysis of the papers we reviewed. We begin with a brief summary of the main public funding mechanisms for subsidizing infertility treatment and their characteristics.

Within Europe, six countries offer 'full public funding' for fertility treatment to eligible couples or individuals. Full coverage is defined as 81% or more of the cost of at least one cycle of intrauterine insemination and/or in vitro fertilization and/or intracytoplasmic sperm injection. Outside of Europe, both Israel and New Zealand provide full coverage through their national health services and in Canada, Ontario provides full funding through its provincial health plan.

Within Europe, 19 countries offer partial public funding for fertility treatment to eligible couples or individuals, with the remainder of the costs borne by the individuals themselves. Outside Europe, Australia provides partial funding for infertility treatment. Partial public funding is defined as less than 81% of the cost of at least one cycle of intrauterine insemination and/or in vitro fertilization and/or intracytoplasmic sperm injection.

The countries that provide partial public funding require substantial out-of-pocket payments from patients. For example, Austria requires a third of the cost be paid by patients' out-of-pocket payments; Finland requires the patient to pay 25% of the costs of investigations, 40% of the medical specialist's fee and up to 58% of the medicines; Germany requires the patient to pay between 25% and 50% of the total costs of treatment depending on the region of residence; and Hungary requires that between 30% and 70% of the cost of gonadotrophic drugs be paid by the patient. Since 2008, the number of countries providing some public funding has increased, but funding practice has changed and the main change noted was a reduction in public funding per patient treated and an increase in out-of-pocket payments by patients.

In six countries examined, the patient must claim a reimbursement for assisted reproductive technologies from the national health plan, which implies that patients may have to pay up front. In 11 jurisdictions the provider is paid directly by the national health plan, meaning patients pay their out-of-pocket contribution only. In five countries the provider can be paid either by the patient or the national health plan.

Twenty-two countries from both within and outside Europe provide full or partial public funding for preimplantation genetic diagnosis. Nineteen countries from within and outside Europe provide full or partial funding for intrauterine insemination, and three countries do not fund intrauterine insemination. Twenty-three countries provide full or partial funding for in vitro fertilization or intracytoplasmic sperm injection. The number of cycles funded through the public health service varies, from one cycle in Ukraine to a limitless number of cycles in Australia, Czech Republic, Estonia and Israel. Seventeen countries provide funding for three to six cycles. The number of cycles that each health system is allowed to fund using public monies appears to be related to the priority placed on infertility as a problem and, separately, to the other health priorities competing for the same funding. Nine countries publicly fund patients accessing assisted reproductive therapies in a network of private clinics, six countries publicly fund patients accessing public clinics only, and five countries fund a mix of public and private services.

From the papers we reviewed, it appears that all of the countries that provide both partial and full public funding towards assisted reproductive technologies set criteria for access to this funding. These criteria can be grouped into two broad categories: clinical and social. Clinical criteria include a female upper age limit and the need for a medical indication, and the BMI and smoking status of applicants. In addition, there may be restrictions on the number of embryos transferred. Social criteria include civil or marital status, previous children and child protection.

Seventeen countries have set an upper female age limit of 39 years or under; 13 countries have set an age limit ranging from 42 to 50; and two countries do not report setting any age limit. These differences reflect the variation among countries that set upper age limits as part of criteria to access public funding. The underlying logic of setting a female upper age limit as part of the criteria appears to rest on the grounds of safety and cost-effectiveness. According to Mladovsky and Sorenson, '…[public funding] coverage is often limited to

younger women, as the available evidence suggests declining effectiveness and increasing costs and safety issues in women aged 40 and older…' p114.[32] Two recent primary studies and one systematic review suggest that at least some of the available evidence does not report favourable outcomes for women over the age of 40. For example, Ouhilal and colleagues report that for women over the age of 40, live birth rates are low and come at a substantial financial cost to a public programme.[85]

Steiner and Jukic report that pregnancy rates in general decline steadily beginning at age 34–35 years, with average rates of 6.6% at age 42–44 years.[98] Menon and colleagues report that in the majority of the studies they reviewed, the findings suggested that the likelihood of achieving a pregnancy was lower for women who were over 40 years.[30] However, despite what appears to be compelling evidence for restricting the public funding of assisted reproductive technology treatment to women aged under 40 years, there remain contentious disputes in the papers we reviewed regarding the ethics of applying upper female age limits. For example, Hodgetts and colleagues report on the views of consumers, clinicians and community members in Australia regarding the setting of criteria for public funding.[25] Consumers and community members favoured a liberal upper age cut-off point of 45 years while clinicians strongly expressed their objections to setting female upper age limits on the grounds that they would be blamed for discriminating against people on the basis of their age. The ideas expressed by all three groups appear to be more supportive of the idea that women should be assessed on their capacity to benefit from treatment rather than subjected to an upper age cut-off point; this is also a point raised and discussed by Carter and colleagues.[51] The variation imposed by many countries in setting a female upper age limit and the disputed nature of this exercise as documented by some authors appear to be linked to the absence of a clinical consensus on what the appropriate cut-off points are for setting an upper female age limit. According to Menon and colleagues, '…to determine the appropriate [age] cut-off points, further research and a discussion around acceptable levels of clinical effectiveness are needed…' p432.[30] However, we know that at present there is a maximum one-in-ten chance of becoming pregnant following in vitro fertilization for women over 40 years, and nine out of ten women aged over 40 years will not become pregnant.

Fourteen jurisdictions require a medical indication (such as a diagnosis of medical infertility or cancer that requires treatment but has a high likelihood of survival) to access publicly funded assisted reproductive technologies. However, there appears to be little agreement in the papers we reviewed regarding the definition of infertility and, consequently, the diagnosis of medical infertility. For example, Mladovsky and Sorenson point to some of the main contradictions present in attempts to define infertility, pointing out that '…It has been argued that infertility is not a disease, but… rather a symptom of a possible underlying disease… the term "infertility" covers a range of disorders, from sterility to possibly normal fertility when the period of non-conception used to define infertility is short in duration…[Additionally] there is also no clear distinction between the terms "subfertility" and "infertility"…' p117.[32] When Gurunath and colleagues reviewed the literature on how infertility was defined in prevalence studies, they reported a binary distinction between the demographic definition of infertility, i.e. the absence of a live birth, and the epidemiological definition, which is based on the woman 'trying for' or 'time to' a pregnancy. The

epidemiological definition appears to be a pragmatic choice for clinicians where involuntary infertility is often diagnosed and defined as a period of time where active sexual intercourse has occurred regularly without conception.

Eight countries specify, either in law or through agreement, that women in their early to mid-thirties will only have a single embryo transferred for the first two or three attempts. This practice is in order to minimize the number of multiple births and reduce the complications associated with multiple births such as premature delivery, low birth weight, need for assisted delivery and congenital abnormalities. McLernon and colleagues combined the results from eight randomised controlled trials in a meta-analysis and reported that multiple birth rates were 2% for single-embryo transfer compared with 29% for double-embryo transfer. They also reported that the odds of delivering a full-term (i.e., delivery after 37 weeks gestation) singleton birth after elective single-embryo transfer was almost five times higher than the odds of a term birth after double-embryo transfer.[102] However, despite what appears to be compelling evidence that restricting the transfer of embryos can reduce the rate of multiple births per cycle, only a minority of countries incentivize this practice as part of the criteria for accessing public funding. This approach appears to be linked to the argument that some patients prefer to have double-embryo transfer due to the improved chances of a live birth.

Only four countries (New Zealand, England, Scotland and Wales) report including BMI in their criteria for accessing funding for in vitro fertilization or intracytoplasmic sperm injection. Rittenberg and colleagues, who combined the results of 33 studies in their meta-analysis, reported that women with a BMI of more than 25 had lower clinical pregnancy and live birth rates and a higher rate of miscarriage when compared to women with a BMI of less than 25.[104] The same four countries also require that patients accessing assisted reproductive technology treatment have not been smoking for at least three months prior to treatment. Waylen and colleagues, who combined the results of 21 studies in their meta-analysis, report that compared with non-smokers, women who were smokers at the time of treatment had a lower live birth rate per cycle, a decreased clinical pregnancy rate and a higher rate of miscarriage and ectopic pregnancy.[105]

Of the 36 countries with published criteria covering civil or marital status, just over half entitle all adults, regardless of civil or marital status, access to assisted reproductive technologies. As may be expected, there is an absence of evidence from the papers we reviewed that would justify the inclusion of civil or marital status as part of criteria to meet to access funding for infertility treatment. Indeed, as observed by Berg Brigham and colleagues '… the restriction based on sexual orientation and relationship status is unique to fertility treatments among healthcare goods…' p669.[3]

There are direct and indirect costs to be considered when decisions on public funding for assisted reproductive technology treatment are adjudicated on. The direct costs include physicians' consultations, nursing services, medication, ultrasound scanning, laboratory tests, clinical procedures, hospital charges and administration charges. The indirect costs can include treatment complications, episodes of ectopic pregnancy, patient travel costs and lost employment productivity. In addition, there are indirect costs associated with inappropriate

use of treatment; for example, costs related to achieving a live birth for women over 40 years due to much higher failure rates. For example, the cost implications of not setting a female upper age limit are reflected in the results of a retrospective evaluation of the Quebec public funding programme for in vitro fertilization. The cost ranged from Can$43,153 for a single baby born to a woman aged 40 years, and Can$103,994 for those aged 43 years; for those aged 44 years, the mean cost of failed in vitro fertilization was Can$597,800 – no babies were born to this group.[84]

The main benefit of providing public funding for infertility treatment identified in the papers we reviewed includes improving access to treatment by reducing out-of-pocket payments. The larger the out-of-pocket expense for the patient, the less likely they are to avail of assisted reproductive technologies.[2, 8, 9] It is anticipated that providing a significant proportion of public funding will encourage women from lower socioeconomic groups to use this intervention, but proportionally women in the higher socioeconomic groups are more likely to use the service. Women in higher socioeconomic groups make greater use of assisted reproductive technology services in countries where this has been measured.[15, 27]

There are also clinical benefits to be accrued which can in tandem reduce the pressure on public spending. For example, many countries view public funding as a method of introducing safer embryo transfer practices and thereby reducing the incidence of multiple pregnancy and its associated complications and costs. A number of countries have enacted regulations to restrict the number of embryos transferred. Regulation is sometimes connected to public funding and has resulted in a significant reduction in multiple pregnancies without causing a decrease in cumulative pregnancy rates.[2] It is estimated that the decrease in multiple birth rates associated with assisted reproductive technology treatment in Australia between 2002 and 2008 resulted in the saving of AU$47.6 million of public funds in birth admission costs alone.[8]

In some of the papers we reviewed, there are inferred benefits to the wider society when public funding for fertility treatment is approved. This inference is based on the assumption that public funding for fertility treatment is a social investment towards arresting the declining infertility rate and boosting the growth of future populations and overall revenue receipts. For example, in the UK an investment of £12,931 to achieve an in vitro fertilization singleton is actually worth 8.5 times this amount to the UK Treasury in discounted future tax revenue.[10] Moreover, there are additional estimates based on lifetime tax calculations (for 80 years), showing that the cost of children conceived through in vitro fertilization breaks even at around 40 years, compared with 38 years for a natural conception, and that funding of in vitro fertilization by the state represents good value for money (an indirect benefit).[10, 19, 45] However, these estimates and others cited in this review are based on reasonable assumptions about revenues and costs as they stand currently. It may be unwise to uncritically accept these projections given that the underlying assumptions are that economic conditions may be comparable 80 years into the future. Nonetheless, the papers reviewed suggest that the overall economic cost to society is relatively modest in the context of public spending from the overall health budget. Authors from Alberta, Canada have modelled outcomes for different age subgroups of women based on the potential introduction of three different kinds of state support: restrictive, permissive and somewhere

between restrictive and permissive, compared with the status quo, which was no funding or regulation. The modelling exercise demonstrated that publicly funded and scientifically regulated assisted reproductive technologies could provide treatment access and reduce healthcare expenditure.

6.3 Key conclusions

Finally, we have identified from the papers we reviewed that there are many countries that provide either full or partial public funding for fertility treatment. We have also identified that provision of public funding is characterized by the variation in funding characteristics. For example, the number of cycles funded, the number of embryos transferred, the use of an upper female age limit and the need for a medical diagnosis to legitimize infertility from a clinical perspective are all applied differently across the countries cited in this review.

In the case of an upper female age limit and restrictions on the number of embryos transferred, there appears to be compelling clinical evidence with which to link these criteria for access to funding. Yet only some countries set an upper female age limit that is consistent with the clinical evidence, and only some attach restrictions on the number of embryo transfers to the provision of public funding. It would appear that there is a conflict in the application of clinical evidence and the choice by some countries to provide public funding.

We suggest, via inferences developed through our review of the papers we included, that on occasion, the decision to provide public funding is influenced by demographic concerns and by appeals to the political and social interests that pertain in some countries. We acknowledge that this conflict is underdeveloped in many of the papers we reviewed and that the inferences we draw are based on a small number of papers. However, we suggest that it is worthwhile to reflect on the lessons from Australia as reported by Watt and colleagues to gain further insight in this argument. Watt *et al.* argue that '…Mirroring the international experience, the public subsidy of assisted reproductive technologies has been a perennially contentious health policy issue in Australia… The use of clinical evidence in these policy debates has been highly variable; while some policy decisions have ostensibly been based on clinical evidence, others have claimed to be based on fiscal rationales and some appear to have been primarily politically motivated…' p201.[43] If fiscal rationales and political pressure are reflective of the international experience as suggested by Watt and colleagues, then this may explain why clinical evidence is often overlooked when some countries decide to fund infertility treatment and set criteria for access to this funding. Additionally, public funding of infertility treatment may improve access to infertility treatment for lower socioeconomic groups; funding may be contingent on restricting the numbers of embryos transferred, thereby improving clinical safety; and funding may be used as a social investment to fund the birth of children who will grow up to sustain the revenue base of a country and maintain a healthy population size.

These are the main lines of logic that we identified in the papers we reviewed which policy-makers can use to justify their decision to provide public funding for infertility treatment. However, these lines of logic are, for the most part, underdeveloped in the literature and

require a fuller in-depth exploration and empirical investigation to adjudicate on their merits, or otherwise, in explaining a) the apparent conflict between clinical evidence and social concerns, and b) the ultimate logic and purpose in providing public funding for infertility treatment. Until such investigations occur, we are compelled to echo the words of Mladovsky and Sorenson, who suggest that in the contested discourse of public funding and infertility treatment, '… while clinical and economic considerations are likely to remain central to decision-making… they cannot be easily detangled from social, political, ethical, and even philosophical dimensions… while the rationales for public funding are often divergent, contradictory, overlapping, and inconclusive, taken together they provide guideposts which signal important issues for consideration…' p124.[32]

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Appendices

Appendix 1 Characteristics of 61 peer-reviewed papers that provided data to answer the four review questions

Citation	Focus	Methods
Agarwal *et al*. (2015) A unique view on male infertility around the globe. *Reproductive Biology and Endocrinology*, 13: 37.[106]	Reports on global rates of male infertility.	An umbrella review of systematic reviews, meta-analysis and primary studies.
Practice Committee of the Society for Assisted Reproductive Technology and Practice Committee of the American Society for Reproductive Medicine (2012) Elective single-embryo transfer. *Fertility and Sterility*, 97(4): 835–842.[103]	A review of the literature on elective single-embryo transfer to provide guidance on patient selection and discuss barriers to utilization.	A literature review.
Ata and Seli (2010) Economics of assisted reproductive technologies. *Current Opinion in Obstetrics & Gynecology*, 22(3): 183–188.[2]	Overview of economic aspects of ART and implications for the use and practice of ART. Explicit reference to public funding.	Overview of secondary data sources.
Balabanova and Simonstein (2010) Assisted reproduction: a comparative review of IVF policies in two pro-natalist countries. *Health Care Analysis*, 18(2): 188–202.[1]	Assessment of ART funding policies in Israel and Bulgaria. Explicit reference to public funding.	Secondary data analysis on women from Israel and Bulgaria.
Berg Brigham *et al.* (2013) The diversity of regulation and public financing of IVF in Europe and its impact on utilization. *Human Reproduction*, 28(3): 666–675.[3]	Comparison of regulation and public financing of IVF in Europe and implications for use. Explicit reference to public funding.	Secondary data analysis of 2009 data from the ESHRE.
Birenbaum-Carmeli (2009) The politics of 'The Natural Family' in Israel: state policy and kinship ideologies. *Social Science & Medicine*, 69(7): 1018–1024.[4]	Analysis of ART policy in Israel and physicians' opinions. Explicit reference to public funding.	Policy analysis and interviews with ART practitioners in Israel.
Bissonnette *et al.* (2011) Working to eliminate multiple pregnancies: a success story in Quebec. *Reproductive BioMedicine Online*, 23(4): 500–504.[5]	Comparison of embryo transfers in Quebec before and after policy and legislation change. Explicit reference to public funding.	Secondary data analysis of data on embryo transfer numbers in 2009 and 2010.

Citation	Focus	Methods
Bretonnière (2013) From laboratories to chambers of parliament and beyond: producing bioethics in France and Romania. *Social Science & Medicine*, 93: 95–102.[6]	Comparison of ART policies in France and Romania since 1980. Explicit reference to public funding.	Policy analysis of ART in France and Romania.
Carter and Braunack-Mayer (2011) The appeal to nature implicit in certain restrictions on public funding for assisted reproductive technology. *Bioethics*, 25(8): 463–471. [50]	To what degree we should defer to nature in the conduct of medicine.	A theoretical paper focusing on a selection of the literature.
Carter *et al.* (2013) Should there be a female age limit on public funding for assisted reproductive technology? *Journal of Bioethical Inquiry*, 10(1): 79–91.[51]	Should there be a female age limit on public funding for assisted reproductive technology (ART)?	A theoretical paper looking at a selection of the literature and inter-country comparison between New Zealand and Swedish policies.
Chambers *et al.* (2009) The economic impact of assisted reproductive technology: a review of selected developed countries. *Fertility and Sterility*, 91(6): 2281–2294.[7]	Comparison of regulation and economic aspects of ART in developed countries. Explicit reference to public funding.	Comparative policy and economic analysis of USA, UK, Canada, Scandinavia, Japan and Australia on the cost of IVF; secondary data analysis from 2006.
Chambers *et al.* (2011) Assisted reproductive technology: public funding and the voluntary shift to single embryo transfer in Australia. *The Medical Journal of Australia,* 195(10): 594–598.[8]	To calculate the cost savings in Australia from the shift to single-embryo transfer Explicit reference to public funding.	Secondary data analysis of data from 2002–2008.
Chambers *et al.* (2012) A reduction in public funding for fertility treatment – an econometric analysis of access to treatment and savings to government. *BMC Health Services Research*, 12: 142.[9]	To evaluate the impact of a policy change in Australia; in 2010, restrictions were introduced on the amount paid under the Medicare scheme, the government's universal insurance scheme. Explicit reference to public funding.	Secondary data analysis of Medicare data in Australia from 2007 and 2011.
Chambers *et al.* (2013a) What can we learn from a decade of promoting safe embryo transfer practices? A comparative analysis of policies and outcomes in the UK and Australia, 2001–2010. *Human Reproduction*, 28(6): 1679–1686.[11]	A comparative analysis of policies and outcomes in the UK and Australia from 2001–2010 on multiple birth rates. Explicit reference to public funding.	Secondary data analysis of HFEA ART registry, Australian and New Zealand databases.

Citation	Focus	Methods
Chambers *et al.* (2013b) Acceptable cost for the patient and society. *Fertility and Sterility*, 100(2): 319–327.[13]	Review of the costs and consequences of ART in different locations. Explicit reference to public funding.	Review of the literature.
Chambers *et al.* (2013c) Socioeconomic disparities in access to ART treatment and the differential impact of a policy that increased consumer costs. *Human Reproduction*, 28(11): 3111–3117.[15]	To evaluate the impact of a policy change in Australia; in 2010 restrictions were introduced on the amount paid under the Medicare scheme, the government's universal insurance scheme; slightly different focus than that in Chambers *et al.* 2012 mentioned previously in this table. Explicit reference to public funding.	Secondary data analysis of Medicare data in Australia between 2007 and 2011.
Chambers *et al.* (2014a) The impact of consumer affordability on access to assisted reproductive technologies and embryo transfer practices: an international analysis. *Fertility and Sterility*, 101(1): 191–198.[17]	To quantify the impact of consumer cost of ART use and the number of embryos transferred. Some reference to funding policies.	Secondary data analysis of women undergoing ART treatment.
Connolly *et al.* (2008) Long-term economic benefits attributed to IVF-conceived children: a lifetime tax calculation. *American Journal of Managed Care*, 14(9): 598–604.	To estimate the economic benefits attributed to IVF-conceived children. Mention of removing financial barriers to IVF.	Secondary data analysis of US data.
Connolly *et al.* (2009a) Assessing long-run economic benefits attributed to an IVF-conceived singleton based on projected lifetime net tax contributions in the UK. *Human Reproduction*, 24(3): 626–632.[10]	To estimate the economic benefits attributed to IVF-conceived single children in the UK. Mention of potential for public funding in the UK.	Secondary data analysis
Connolly *et al.* (2009b) The impact of introducing patient co-payments in Germany on the use of IVF and ICSI: a price-elasticity of demand assessment. *Human Reproduction*, 24(11): 2796–2800.[22]	Assessing the impact of Germany introducing a 50% co-payment policy for ART in 2004. Mention of public funding in Germany.	Secondary data analysis of German data.

Citation	Focus	Methods
Connolly *et al.* (2010) The costs and consequences of assisted reproductive technology: an economic perspective. *Human Reproduction Update*, 16(6): 603–613.[24]	To assess the costs and consequences of ART in a number of countries. Implicit reference to public funding.	A review of key studies.
Connolly *et al.* (2011) The long-term fiscal impact of funding cuts to Danish public fertility clinics. *Reproductive BioMedicine Online*, 23(7): 830–837.[12]	To evaluate the reductions in public funding in Denmark. Explicit reference to public funding.	Policy analysis and secondary data analysis from Denmark.
Cook *et al.* (2011) Assisted reproductive technology-related multiple births: Canada in an international context. *Journal of Obstetrics and Gynaecology Canada*, 33(2): 159–167.[14]	To compare the rate of ART multiple births in Canada with other countries. Implied reference to public funding.	Secondary data analysis of 21 countries.
Dietrich and Wevers (2010) Effects of the Statutory Health Insurance Modernization Act on the supply and expenditure situation in cases of assisted reproductive technologies in Germany. *Fertility and Sterility*, 93(3): 1011–1013.[88]	To examine the effect of the increase to the co-payment for ART in Germany.	A retrospective analysis of outpatient health insurance members of the Statutory Health Insurance both in total and a subgroup.
Dunn *et al.* (2014) An international survey of assisted reproductive technologies (ARTs) policies and the effects of these policies on costs, utilization, and health outcomes. *Health Policy*, 116(2–3) 238–263.[16]	To compare existing policies on access to ART and the effects of these policies on costs, utilization and health outcomes. Explicit reference to public funding.	A systematic review of biomedical and social science literature.
ESHRE Task Force on Ethics and Law (2010) Lifestyle-related factors and access to medically assisted reproduction. *Human Reproduction*, 25(3): 578–583.[108]	This document briefly summarizes the evidence concerning the impact of three lifestyle-related factors (obesity, tobacco smoking and alcohol consumption) on both natural and assisted reproduction (IVF) and discusses the implications of this for the practice of medically assisted reproduction in the light of relevant ethical principles.	Literature review
ESHRE Capri Workshop Group (2010) Europe the continent with the lowest fertility. *Human Reproduction Update*, 16(6): 590–	To assess trends in fertility rates. Some mention of government funding for ART.	Review of relevant literature.

Citation	Focus	Methods
602.[31]		
Farquhar *et al.* (2010) A comparative analysis of assisted reproductive technology cycles in Australia and New Zealand 2004–2007. *Human Reproduction*, 25(9): 2281–2289.[18]	To analyse funding approaches in Australia and New Zealand from 2004–2007. Explicit reference to public funding.	Secondary analysis of Australia and New Zealand database.
Fournier *et al.* (2013) Access to assisted reproductive technologies in France: the emergence of the patients' voice. *Medicine, Health Care and Philosophy*, 16(1): 55–68.[92]	An interdisciplinary clinical ethics study concerning access to ART in France for groups considered ethically problematic in France (over-age or sick parents, surrogate mothers).	A qualitative primary study.
Gillett *et al.* (2012) Development of clinical priority access criteria for assisted reproduction and its evaluation on 1386 infertile couples in New Zealand. *Human Reproduction*, 27(1): 131–141.[20]	Evaluation of access criteria for publicly funded ART in New Zealand. Explicit reference to public funding.	Data collected from couples between 1998 and 2005.
Gooldin (2013) 'Emotional rights', moral reasoning, and Jewish–Arab alliances in the regulation of in-vitro-fertilization in Israel: theorizing the unexpected consequences of assisted reproductive technologies. *Social Science & Medicine*, 83: 90–98.	To understand the exceptional use of IVF in Israel. Explicit reference to public funding.	A case study of a public dispute from 2003–2004 in Israel over the extent of public funding for fertility treatments.
Gurunath *et al.* (2011) Defining infertility–a systematic review of prevalence studies. *Human Reproduction Update*, 17(5): 575–588.[101]	To determine how infertility has been defined in prevalence studies.	A systematic review of the literature included 39 studies.
Hodgetts *et al.* (2012) What counts and how to count it: physicians' constructions of evidence in a disinvestment context. *Social Science & Medicine*, 75(12): 2191–2199.[23]	This paper analyses the constructions of evidence by ART physicians in the context of deliberative stakeholder engagements (held in 2010) around options for restricting public subsidies of ART in Australia. Explicit reference to public funding.	Primary data collected via a series of deliberative stakeholder engagements in Australia with ART physicians, non-partisan citizens, ART consumers and state and federal health policy advisors.
Hodgetts *et al.* (2014) Disinvestment policy and the public funding of assisted	To analyze the views of key stakeholders on disinvestment of ART.	Primary data were collected via deliberative engagements with groups of ART consumers,

Citation	Focus	Methods
reproductive technologies: outcomes of deliberative engagements with three key stakeholder groups. *BMC Health Services Research*, 14: 204.[25]	Explicit reference to public funding.	clinicians and community members. Discussions were transcribed and subject to thematic analysis.
Klemetti *et al.* (2007) Resource allocation of in vitro fertilization: a nationwide register-based cohort study. *BMC Health Services Research*, 7: 210. [27]	To describe the allocation of resources for IVF by women's age, socioeconomic position, area of residence and treatment sector (public versus private) and to discuss how fairly the IVF resources are allocated in Finland. Some reference to public funding.	A cohort study based on secondary data analysis of data sources in Finland.
Kocourkova *et al.* (2014) Demographic relevancy of increased use of assisted reproduction in European countries. *Reproductive Health*, 11: 37.[33]	To evaluate the demographic importance of ART's increased use and to examine its impact on both the fertility rate and birth timing. Explicit reference to public funding.	Secondary data analysis based on demographic and ART data collected by the European IVF-Monitoring (EIM) Consortium for the European Society of Human Reproduction and Embryology.
Maeda *et al.* (2014) Age-specific cost and public funding of a live birth following assisted reproductive treatment in Japan. *Journal of Obstetrics and Gynaecology Research*, 40(5): 1338–1344.[28]	To calculate and assess the cost of ART treatment cycles and live births in Japan in 2010. Explicit reference to public funding.	Secondary data analysis of ART cycles registered with the national registry of assisted reproductive treatment during 2010. Costs were calculated using a decision analysis model.
Maheshwari *et al.* (2011) Global variations in the uptake of single embryo transfer. *Human Reproduction Update*, 17(1): 107–120.[36]	To identify the use of single-embryo transfers internationally. Explicit reference to public funding.	A systematic review from 1978–2010.
McLernon *et al.* (2010) Clinical effectiveness of elective single versus double embryo transfer: meta-analysis of individual patient data from randomised trials. *BMJ*, 341: c6945.[102]	To compare the effectiveness of elective single-embryo transfer versus double-embryo transfer on outcomes of live birth, multiple live birth, miscarriage, preterm birth and term singleton birth.	A systematic review of trials; eight RCTs included in the meta-analysis.
Menon *et al.* (2015) Defining eligibility criteria for funding policies around in vitro fertilization. *International Journal of Technology Assessment in Health Care*, 31(6): 426–433.[30]	Assess the science of certain patient characteristics on the safety and effectiveness of IVF.	A systematic review of the literature using qualitative analysis and including 10 systematic reviews and seven primary papers. Papers published between 2007 and 2014 were included. Systematic searches and

Citation	Focus	Methods
		critical appraisal were included. Heterogeneity among included papers meant a narrative synthesis was performed.
Mladovsky and Sorenson (2010) Public financing of IVF: a review of policy rationales. *Health Care Analysis*, 18(2): 113–128.[32]	To review five rationales for public funding of IVF. Explicit reference to public funding.	A review of relevant literature.
National Institute for Health and Clinical Excellence (2013b) *Fertility: assessment and treatment for people with fertility problems*. London: Royal College of Obstetricians and Gynaecologists.[99]	This guideline covers diagnosing and treating fertility problems. It aims to reduce variation in practice and improve the way fertility problems are investigated and managed.	A systematic review of the current evidence and extensive stakeholder consultations.
Peeraer *et al.* (2014) The impact of legally restricted embryo transfer and reimbursement policy on cumulative delivery rate after treatment with assisted reproduction technology. *Human Reproduction*, 29(2): 267–275.[34]	What is the impact of the Belgian legislation (1 July 2003) coupling reimbursement of six assisted reproduction technology (cycles per patient with restricted embryo transfer policy on cumulative delivery rate per patient? Explicit reference to public funding.	A retrospective cohort study of a study group after implementation of the new ART legislation (July 2003 to June 2006) and a control group from before legislation (July 1999 to June 2002).
Rittenberg *et al.* (2011) Effect of body mass index on IVF treatment outcome: an updated systematic review and meta-analysis. *Reproductive BioMedicine Online*, 23(4): 421–439.[104]	To evaluate the effect of a higher BMI on treatment outcome following IVF/ICSI treatment.	A systematic review and meta-analysis of studies.
Rauprich *et al.* (2010) Who should pay for assisted reproductive techniques? Answers from patients, professionals and the general public in Germany. *Human Reproduction*, 1225–1233.[79]	To examine the views of the public and professionals in Germany on the financing of ART.	A national survey among patients, professionals (physicians and other academics in IVF centres, psychosocial counsellors, medical ethicists, social lawyers, health politicians) and the general public.
Santos-Ribeiro *et al.* (2016) Trends in ectopic pregnancy rates following assisted reproductive technologies in the UK: a 12-year nationwide analysis including 160,000 pregnancies. *Human Reproduction*, 31(2): 393–402. [58]	Have the advancement of assisted reproductive technologies and changes in the incidence of specific causes of infertility altered ectopic pregnancy rates over time in the United Kingdom?	A population-based retrospective analysis on all pregnancies following ART cycles carried out in the UK between 2000 and 2012 included in the anonymized database of the Human Fertilisation and Embryology Authority.

Citation	Focus	Methods
Shaulov *et al.* (2015) Public health implications of a North American publicly funded in vitro fertilization program; lessons to learn. *Journal of Assisted Reproduction and Genetics*, 32(9): 1385–1393.[44]	To determine trends in practice and outcomes that occurred since the implementation of the publicly funded in vitro fertilization (IVF) and single-embryo transfer (SET) program in Quebec in August 2010. Explicit reference to public funding.	Secondary data analysis on all IVF cycles performed from the 2009–2010 to 2012–2013 fiscal years.
Silva and Barros (2012) Perspectives on access to in vitro fertilization in Portugal. *Revista de Saúde Pública*, 46(2): 344–350.[35]	To analyse users' reasons for choosing public or private IVF services in Portugal. Explicit reference to public funding.	Primary study using semi-structured interviews with IVF patients in Portugal from 2005–2006.
Simonstein (2010) IVF policies with emphasis on Israeli practices. *Health Policy*, 97(2–3) 202–208.[37]	To review IVF policies in several countries with specific focus on Israel. Explicit reference to public funding.	A review of the literature dealing with IVF outcomes, policies and practices.
Simonstein *et al.* (2014) Assisted reproduction policies in Israel: a retrospective analysis of in vitro fertilization–embryo transfer. *Fertility and Sterility*, 102(5): 1301–1306.[38]	An analysis of IVF policy in Israel. Explicit reference to public funding.	A review of 535 patient files.
Sol Olafsdottir *et al.* (2009) Access to artificial reproduction technology in the Nordic countries in 2004. *Acta Obstetricia et Gynecologica Scandinavica*, 88(3): 301–307.[40]	To survey access to ART in Nordic countries. Potential reference to public funding.	Primary study surveying clinics and legislation in Nordic countries.
Steiner and Jukic (2016) Impact of female age and nulligravidity on fecundity in an older reproductive age cohort. *Fertility and Sterility*, 105(6): 1584–1588.[98]	To provide female age-related estimates of fecundity and incidence of infertility by history of prior pregnancy among women 30–44 years of age.	Prospective time-to-pregnancy cohort study of women aged between 30 and 44 years, attempting to conceive for ≤3 months with no known history of infertility, polycystic ovarian syndrome or endometriosis.
Street *et al.* (2011) News and social media: windows into community perspectives on disinvestment. *International Journal of Technology Assessment*	A case study of public funding for ART services using media coverage. Explicit reference to public	Thematic analysis of relevant data from 59 media articles, 39 discussion forums, 13 blogs and three Facebook pages relating to the case study.

Citation	Focus	Methods
in Health Care, 27(4): 376–383.[42]	funding.	
Svensson *et al.* (2008) Long-term fiscal implications of subsidizing in-vitro fertilization in Sweden: a lifetime tax perspective. *Scandinavian Journal of Public Health,* 36(8): 841–849.[45]	To estimate the lifetime future tax revenues of an IVF-conceived child to establish whether public subsidy of IVF represents sound fiscal policy. Potential reference to public funding.	A modified generational accounting model was developed to calculate the net present value (NPV) of average investment costs required to achieve an IVF-conceived child.
Umstad *et al.* (2013) Multiple deliveries: the reduced impact of *in vitro* fertilisation in Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 53(2): 158–164.[46]	To determine the influence of a policy of single-embryo transfer (SET) on the rate of multiple deliveries in Australia. Some references to public funding.	The authors used population data to compare the prevalence of twin and higher-order multiple births in women giving birth in Australia before and after the implementation of the 'Reproductive Technology Accreditation Committee Code of Practice' 2001 and 2005 revisions for ART units.
Vaidya *et al.* (2015) Assisted reproductive technologies in Alberta: an economic analysis to inform policy decision-making. *Journal of Obstetrics and Gynaecology Canada*, 37(12): 1122–1130.[89]	A study to evaluate the cost-effectiveness and budget impact of providing ARTs in Alberta under three different policy scenarios (a 'restrictive' policy, a policy based on Quebec's model, and a 'permissive' policy) in comparison with the status quo.	The authors developed an economic model by combining a state transition Markov model and a decision tree. The primary outcome was cost per healthy singleton.
Vélez *et al.* (2014) Universal coverage of IVF pays off. *Human Reproduction*, 29(6): 1313–1319.[48]	What was the clinical and economic impact of universal coverage of IVF in Quebec, Canada, during the first calendar year of implementation of the public IVF programme? Explicit reference to public funding.	This prospective comparative cohort study involved 7,364 IVF cycles performed in Quebec between 2009 and 2011 and included an economic analysis.
Vikström *et al.* (2015) Mental health in women 20–23 years after IVF treatment: a Swedish cross-sectional study. *BMJ Open*, 5(10): e009426.[57]	To assess self-perceived mental health in women treated with in vitro fertilization 20–23 years previously, while comparing them to a reference group.	A cross-sectional study of 520 women who had undergone at least one IVF cycle between 1986 and 1989.
Watt *et al.* (2011) Assisted reproductive technologies: a systematic review of safety and effectiveness to inform disinvestment policy. *Health*	To examine the literature on the benefits and harms of ART to inform policy recommendations in Australia.	A systematic review from 1994–2009.

Citation	Focus	Methods
Policy, 102(2–3): 200–213.[43]	Potential for reference to public funding.	
Waylen *et al.* (2009) Effects of cigarette smoking upon clinical outcomes of assisted reproduction: a meta-analysis. *Human Reproduction Update*, 15(1): 31–44.[105]	To investigate differences in outcomes of ART between females actively smoking at time of treatment and females not actively smoking at treatment time.	A systematic review including cohort and case-control studies resulting in 21 studies included in the meta-analysis.
Záchia *et al.* (2011) Assisted reproduction: what factors interfere in the professional's decisions? Are single women an issue? *BMC Women's Health*, 11(21).[60]	To examine the factors prioritized by ART professionals when deciding on whether to accept to perform assisted reproduction and to show any existing cultural differences.	Cross-sectional study involving 224 healthcare professionals working with assisted reproduction in Brazil, Italy, Germany and Greece.
Total = 61		

Appendix 2 Extraction table for Question 2: Costs and benefits of assisted reproductive technologies

Extraction Table for Question 2							
		Public funding					
		Patient		**Provider**		**Policy-maker/funder**	
		Benefit	**Cost**	**Benefit**	**Cost**	**Benefit**	**Cost**
Embryo transfer	Single	The reduction in multiple births has primarily occurred as a result of a voluntary shift to use of SET.[8]	Where there is no public funding there is a tendency to transfer multiple embryos to gain the best chance of a pregnancy but this can lead to multiple births.			The increase of SET means fewer multiple pregnancies, low-weight births, and ongoing costs, including downstream costs in health, education and social services.	Public funding has a cost to the exchequer which may be a political issue – either for or against a government
Cycle rank							
	One						
	Two						
	Three						
	Age effect	The use, success and expenditures of IVF were age-dependent. Numbers and rates of women having	In Japan, the average cost per live birth in women aged ≥45 was 29.6 times higher than that of	The likelihood of a successful outcome is significantly reduced with age. Private clinics may		Policy-makers are likely to limit by age and number of cycles to maximize the chances of successful	Limitations may be perceived as discriminatory.

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
		received IVF were highest among women aged 30–34 years, but the treatment was more intense for older women (number of cycles per woman). The success rate per cycle and per woman decreased with age.[27]	women aged 35–39 years. This rose sharply in the early 40s and upwards.[28]	opportunistically provide older patients with expensive treatment that has little chance of success.		outcomes for those most likely to deliver a live birth.	
Live birth							
Type of live birth	Single						
	Twin		Twins and triplets are 3.9 and 10.6 times more likely, respectively, to be transferred to another hospital than singleton				Twin births and low-weight births have a significant financial impact on public funds.[59]

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
			infants. Multiple births also continue to generate higher long-term medical, education and social services costs than singleton births.[8]				
	Triplets		Multiple births are associated with significantly increased risks for both mothers and babies, including pregnancy and delivery complications, preterm birth, long-term disability, and death.[8]				Triplets cost more than double the cost of twins for delivery, and higher-order multiples are three times the cost of triplets.[59]
	Embryo transfer	Treatment affordability has also been shown to					

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
		influence the number of embryos transferred.[13]					
Full public funding			Higher levels of utilization were found in countries with low out-of-pocket expenses, either through low treatment costs (as was the case in Japan) or generous public funding (as was the case in Australia and Scandinavia).[59]				Affordability was also independently and significantly associated with the number of embryos transferred, with higher numbers of embryos transferred in jurisdictions with relatively expensive ART.[17]
	Out-of-pocket effect	The availability of public funding allows a greater number of	Affordability had a strong and robust association with	Clinics would see a large increase in business volume.			A relatively larger fall in consumer cost

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
		people to avail of ART services.	utilization, with a 10 percentage point decrease in affordability predicted to, on average, decrease utilization by 32%.[17]				would be needed to drive more conservative embryo transfer practices in jurisdictions with already high numbers of embryos being transferred, such as the USA.[17]
Partial public funding			Studies have shown that when ART treatment costs increase, not only is equity of access reduced, but a financial incentive is created to transfer multiple embryos			Policy-makers are able to influence best practice in clinics where they are making a contribution to costs.	

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
			during treatment, thereby increasing the chance of a pregnancy in one cycle.[9]				
	Out-of-pocket effect		A change in Australia's funding system to limit the government's exposure to fee rises increased the out-of-pocket costs to patients for ART and IUI treatment increased on average by AU$500–AU$1,000 for fresh cycles, and AU$300–AU$500 for frozen cycles and IUI cycles. For fresh cycles, this resulted in a				

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
			significant reduction in cycles across all age groups.[9]				
Unlimited public funding		Patients have access to treatments that would not have been affordable.			A review of the Extended Medicare Safety Net (EMSN) scheme in Australia concluded that due to the unlimited nature of the benefits available through the scheme some of the 68 private fertility clinics opportunistically raised their fees in the	In Quebec, the introduction of universal IVF coverage increased the number of clinical pregnancies and projected live births. The reduced medical cost per cycle and reduced cost per live birth indicate that savings are being achieved with the new public IVF programme. Despite the surge in demand due to the newly available	Scarce resources are being used, which gives rise to opportunity cost of another service foregone.

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
					knowledge that the majority of the cost would be funded by government. This meant that patients did not fully see the reduction in out-of-pocket expenses.[9]	possibility for many to fulfil a previously unmet need, and despite the increased cost of IVF treatment compared with the former tax-credit reimbursement system, the efficiency of the policy to reduce cost per baby has been achieved.[48]	
Limited public funding							
	Supply						
	Waiting lists		In Sweden, the national healthcare system has established limits on the number of IVF cycles covered by				

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
			the system and which indications allow couples treatment. This has caused waiting lists for treatment, which exacerbates the situation because of the impact of age on fecundity.[45]				
Costs of ART treatment cycles and procedures (USD 2006)	Fresh transfer cycle						
	USA		US$12,513				
	Canada		US $8,500				
	UK		US $6,534				
	Scandinavia		US $5,549				
	Japan		US $3,956				
	Australia		US $5,645[7]				

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
Total ART treatment costs as a percentage of total healthcare expenditure (USD 2003)							
	USA		0.06%				
	Canada		0.07%				
	UK		0.13%				
	Scandinavia		0.19%				
	Japan		0.09%				
	Australia		0.25%[7]				
Cost per live birth in 2003 for autologous ART treatment cycles (USD 2006)	Cost-effectiveness						
	United States		US$41,132				
	Canada		US$33,183				
	United Kingdom		US$40,364				

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
	Scandinavia		US$24,485				
	Japan		US$24,329				
	Australia		US$25,843[7]				
Price elasticity of demand (PED)		The measure of the responsiveness of demand to changes in cost is known as the price elasticity of demand and is often used by policy-makers to predict how changes in consumer cost will impact consumer behaviour and healthcare budgets.[13]	The reduction in demand for IVF and ICSI cycles in the year following the introduction of patient co-payments in Germany resulted in elasticities of -0.41 and -0.34, respectively. The price elasticity for the combined reduction of IVF/ICSI in relation to the co-payment was estimated to be -0.36 . The cross-price elasticity for Clomifene was close			The PED allows changes in revenue to be predicted when prices rise or fall. The general rule is that if PED is elastic, a rise in price will lead to less spending by consumers, whereas a fall in price will lead to more spending by consumers. The opposite is true for PEDs that are inelastic. Therefore, a small reduction in IVF prices around the mid-range	Price elasticity estimates are used by policy-makers and commercial analysts to predict how future price changes, in this case patient co-payments, are likely to influence demand for products and potential revenue consequences in the case of

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
			to zero (-0.01), suggesting that demand for these interventions are independent of each other and no substitution occurred.[22]			(US$2,775–US$7,565 per cycle) would be expected to increase consumer spending on IVF (revenue) because the percentage change in quantity demanded is greater than that in the price.[7]	commercial organizations.[22]
Socioeconomic disparities in access to ART treatment		IVF is costly, and in countries where IVF is offered only in the private sector its availability depends on a couple's ability to pay. In France, where IVF costs are fully covered by public resources, the use of IVF did not differ according to	Women from higher socioeconomic status quintiles use more ART treatment than those in lower socioeconomic status quintiles, which likely reflects a greater ability to pay for treatment and a greater need for ART treatment as	In Finland, older women (≥40) received 1.4 times more IVF treatment cycles than younger women (≤30). The success rate decreased with age, from 22 live births per 100 cycles among younger women to 6 per 100			

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
		women's socioeconomic position.[27]	indicated by the trend to later childbearing.[15]	among older women. The mean cost of a live birth increased with age: compared to younger women, costs per live birth of older women were threefold. Calculated by population, public expenditure was allocated most to young women and women from the highest socioeconomic position.[27]			
Non-economic benefits of ART		Although difficult to quantify, these benefits are not inconsequential. The popular discourse in					

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
		the scientific and lay media around the topics of 'happiness' and 'a meaningful life' often include discussions about the role that parenthood plays in these life goals.[13]					
Lifetime tax calculation		Minimum out-of-pocket expense to the patient encourages greater utilization of ART.	Financial and legislative barriers to fertility treatments prevent many couples from achieving their desired family size, resulting in fewer children being born.[19]	Minimizing barriers to fertility treatments is likely to have long-term economic benefits that need to be considered when making IVF funding decisions.[19]	It is open to question whether it is valid to relate the potential lifetime tax receipts of an individual to the costs involved in their conception.	The costs attributed to IVF treatment are insignificant in light of the lifetime net tax contributions of IVF-conceived children.[19] An investment of £12,931 to achieve an IVF singleton is actually worth 8.5	Taking the perspective of the government, fewer children born in current generations represents a loss in future tax revenue that would arise from these

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
						times this amount to the UK Treasury in discounted future tax revenue.[10]	children after they enter the workforce.[19]
Downstream costs of multiple pregnancy							A recent cost analysis of preterm infants born in the USA as a result of ART multiple births estimated that the total healthcare cost was ~US$1 billion annually, which approximates the total direct cost of ART treatment in that country. Similarly,

Extraction Table for Question 2							
		Public funding					
		Patient		Provider		Policy-maker/funder	
		Benefit	Cost	Benefit	Cost	Benefit	Cost
							analyses of UK and Australia data have shown that the savings in caring for multiple-birth infants has theoretically cross-subsidized much of the increase in ART utilization in those countries.[13]

Appendix 3 Quality review of systematic reviews using Health Evidence Quality Assessment Tool and their results

Health Evidence Quality Assessment Tool

Health Evidence ™ Helping public heath use best evidence in practice		Quality Assessment Tool – Review Articles

Instructions for completion:
Please refer to the attached dictionary for definition of terms and instruction for completing each section. For each criteria, score by placing a check mark in the appropriate box

First Author:
Year:
Journal:
Reviewer:

CRITERION	YES	NO
Q1 Did the authors have a clearly focused question [population, intervention (strategy, and outcomes(s)]?	Y	
Q2 Were the appropriated inclusion criteria used to select primary studies?	Y	
Q3 Did the authors describe a search strategy that was comprehensive?	Y	
Circle all strategies used: • health databases • psychological databases • social science databases • educational databases • other; • hand searching • key informants • references lists • unpublished		
Q4 Did search strategy cover an adequate number of years	Y	

For question 5, 6, and 8, please choose the column relating to the appropriate methodology. Strike a line through the column that does not apply.

Q5. Quantitative reviews: Did the authors describe the level of evidence in the primary studies included in the review? Level I RCTS only Level II on-randomised, cohort, case-control Level III uncontrolled studies	Q5. Qualitative reviews: Do the authors provide a clear description of the range of method in each of the primary studies included in the review?	Y	
Q6 Quantitative reviews: Did the review assess the methodological quality of the primary studies, including: *(Minimum requirement: **4/7** of the following)* • Research design • Study sample • Participation rates • Sources of bias (confounders, respondent bias) • Data collection (measures of independent/dependent variables) • Follow-up/attrition rates • Data analysis	Q6 Qualitative reviews: Did the review assess the methodological quality of the primary studies, including: *(Minimum requirement: **4/7** of the following)* • Suitability of methodology/paradigm to the research question • Sampling (selection of participants/settings/documentation) • Clear description of context, data collection and data analysis • Rigor: Audit trail Some coding by 2 or more coders, if appropriate Deviant case analysis *negative cases) Respondent validation (member checking) • Triangulation Reflexivity (research and research process) • Relevance (credibility, consistency, applicability, transferability)	Y 4/7	
Q7 Are the results of the [quality] review transparent?		Y	
Q8 Quantitative reviews: Was it appropriate to combine the finding of results across studies	Q8 Qualitative reviews: Is there a description of how reviewers determined results were similar enough cross studies to compare or combine them?	Y	
Q9 Were appropriate methods used for combining or comparing results across studies?		Y, Narrative review	
Q10. Do the data support the author's interpretation?		Y	
	TOTAL SCORE:		

Quality Assessment Rating: (Circle one)
Strong (total score 8 – 10)
Moderate (total score 5 – 7)
Weak (total score 4 or less)

Health Evidence ™

Quality assessment scores for systematic reviews

Systematic reviews	Quality assessment score	1	2	3	4	5	6	7	8	9	10
Agarwal (2015)[106]	Weak	✓	✓	X	X	✓	X	X	X	X	X
Connolly *et al.* (2010)[24]	Weak	X	X	✓	X	X	X	X	✓	✓	✓
Dunn *et al*. (2014)[16]	Moderate	✓	✓	✓	✓	X	X	X	✓	✓	✓
ESHRE Workshop (2010)[31]	Moderate	✓	✓	✓	X	X	X	X	✓	✓	✓
Gurunath *et al*. (2011)[101]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maheshwari *et al.* (2011)[36]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mascarenhas et al (2012)[107]	Moderate	✓	✓	✓	✓	X	X	X	✓	✓	✓
Menon *et al.* (2015)[30]	Strong	✓	✓	✓	✓	X	✓	✓	✓	✓	✓
Nardelli *et al.* (2014)[39]	Strong	✓	✓	✓	✓	X	✓	✓	✓	✓	✓
McLernon *et al.* (2010)[102]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maheshwari *et al.* (2011)[36]	Moderate	✓	✓	✓	✓	✓	X	X	✓	X	X
Watt *et al.* (2011)[43]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waylen et al. (2009)[105]	Strong	✓	✓	✓	✓	✓	✓		✓	✓	✓

Appendix 4 Quality review of economic studies using an adapted CHEERS Checklist and their results

Adapted CHEERS checklist items to include when reporting economic evaluations of health interventions

The **ISPOR CHEERS Task Force Report**, *Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluations Publication Guidelines Good Reporting Practices Task Force* provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

Section/item	Item No	Recommendation	Yes/No or N/A
Title and abstract			
Title	1	Does the paper identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared?	**N/A, as not used as part of the quality assessment**
Abstract	2	Does the paper provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions?	**N/A, as not used as part of the quality assessment**
Introduction			
Background and objectives	3	Does the paper provide an explicit statement of the broader context for the study and present the study question and its relevance for health policy or practice decisions?	
Methods			
Target population and subgroups	4	Does the paper describe characteristics of the base case population and subgroups analysed, including why they were chosen?	
Setting and location	5	Does the paper state relevant aspects of the system(s) in which the decision(s) need(s) to be made?	
Study perspective/approach	6	Does the perspective of the study relate this to the costs being evaluated?	
Comparators	7	Does the paper describe the interventions or strategies being compared and state why they were chosen?	
Time horizon	8	Does the paper state the time horizon(s) over which costs and consequences are being evaluated and detail why time is appropriate?	
Discount rate	9	Does the paper report the choice of discount rate(s) used for costs and outcomes and detail why discount rate is appropriate?	
Choice of health outcomes	10	Does the paper describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance	

		for the type of analysis performed?	
Measurement of effectiveness	11a	*Single study-based estimates:* Does the paper describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data?	
	11b	*Synthesis-based estimates:* Does the paper describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data?	
Measurement and valuation of preference-based outcomes	12	Does the paper describe the population and methods used to elicit preferences for outcomes, estimating resources and costs?	
	13a	*Single study-based economic evaluation:* Does the paper describe approaches used to estimate resource use associated with the alternative interventions and describe primary or secondary research methods for valuing each resource item in terms of its unit cost? Does it describe any adjustments made to approximate opportunity costs?	
	13b	*Model-based economic evaluation:* Does the paper describe approaches and data sources used to estimate resource use associated with model health states and describe primary or secondary research methods for valuing each resource item in terms of its unit cost? Does it describe any adjustments made to approximate opportunity costs?	
Currency, price date, and conversion – standardization	14	Does the paper report the dates of the estimated resource quantities and unit costs and describe methods for adjusting estimated unit costs to the year of reported costs if necessary? Does it describe methods for converting costs into a common currency base and the exchange rate?	
Choice of model	15	Does the paper describe and give reasons for the specific type of decision-analytic model used, providing a figure to show model structure is strongly recommended?	
Assumptions	16	Does the paper describe all structural or other assumptions underpinning the decision-analytic model?	
Analytical methods	17	Does the paper describe all analytical methods supporting the evaluation? (This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half-cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty).	
Results			
Study parameters	18	Does the paper report the values, ranges, references, and, if used, probability distributions for all parameters and report reasons or sources for distributions used to represent uncertainty where appropriate? Does it provide a	

		table to present the input values which is strongly recommended?	
Incremental costs and outcomes	19	For each intervention, does the paper report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups? If applicable, report incremental cost-effectiveness ratios.	
Characterizing uncertainty	20a	*Single study-based economic evaluation:* Does the paper describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective)?	
	20b	*Model-based economic evaluation:* Does the paper describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions?	
Characterizing heterogeneity	21	If applicable, does the paper report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information?	
Discussion			
Study findings, limitations, generalizability, and current knowledge	22	Does the paper summarize key study findings and describe how they support the conclusions reached and discuss limitations and the generalizability of the findings and how the findings fit with current knowledge?	**N/A, as not used as part of the quality assessment**
Other			
Source of funding	23	Does the paper describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis and describe other non-monetary sources of support?	**N/A, as not used as part of the quality assessment**
Conflicts of interest	24	Does the paper describe any potential for conflict of interest of study contributors in accordance with journal policy? In the absence of a journal policy, we recommend that authors comply with International Committee of Medical Journal Editors recommendations.	**N/A, as not used as part of the quality assessment**

Quality assessment score for economic studies

Economic papers	Quality assessment	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Chambers *et al.* (2007)[59]	Strong	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A
Chambers *et al.* (2009)[7]	Moderate	✓	X	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	✓	N/A	N/A
Chambers *et al.* (2011)[8]	Strong	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A
Chambers *et al.* (2012)[9]	Strong	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A
Chambers *et al.* (2013a)[11]	Moderate	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	N/A	N/A
Chambers *et al.* (2013b)[13]	Strong	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	N/A
Chambers *et al.* (2014a)[17]	Strong	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	N/A	N/A	✓	✓	✓	✓	✓	✓	N/A
Chambers *et al.* (2014b)[91]	Strong	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A
Connolly *et al.* (2008)[19]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	N/A
Connolly *et al.* (2009a)[10]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	N/A
Connolly *et al.* (2009b)[22]	Moderate	✓	✓	✓	✓	✓	✓	N/A	✓	✓	N/A	N/A	N/A	✓	✓	N/A	N/A	✓	N/A	N/A
Connolly *et al.* (2011)[12]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	N/A
Klemetti *et al.* (2007)[27]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	✓	N/A	✓	✓	N/A
Maeda *et al.* (2014)[28]	Moderate	✓	✓	✓	✓	N/A	✓	N/A	✓	✓	✓	✓	N/A		N/A	N/A	✓	✓	✓	N/A
Svensson *et al.* (2008)[45]	Strong	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A
Vélez *et al.* (2014)[48]	Moderate	✓	✓	✓	✓	✓	✓	N/A	✓	✓	X	✓	✓	N/A	N/A	✓	N/A	✓	N/A	N/A

Appendix 5 Quality review of quantitative and qualitative studies using MMAT and their results

MMAT instrument

PART I. MMAT criteria & one-page template (to be included in appraisal forms)

Types of mixed methods study components or primary studies	Methodological quality criteria (see tutorial for definitions and examples)	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	• Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*)?				
	• Do the collected data allow address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components).				
	Further appraisal may be not feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative	1.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question (objective)?				
	1.2. Is the process for analyzing qualitative data relevant to address the research question (objective)?				
	1.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected?				
	1.4. Is appropriate consideration given to how findings relate to researchers' influence, e.g., through their interactions with participants?				
2. Quantitative randomized controlled (trials)	2.1. Is there a clear description of the randomization (or an appropriate sequence generation)?				
	2.2. Is there a clear description of the allocation concealment (or blinding when applicable)?				
	2.3. Are there complete outcome data (80% or above)?				
	2.4. Is there low withdrawal/drop-out (below 20%)?				
3. Quantitative non-randomized	3.1. Are participants (organizations) recruited in a way that minimizes selection bias?				
	3.2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes?				
	3.3. In the groups being compared (exposed vs. non-exposed; with intervention vs. without; cases vs. controls), are the participants comparable, or do researchers take into account (control for) the difference between these groups?				
	3.4. Are there complete outcome data (80% or above), and, when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)?				
	4.2. Is the sample representative of the population understudy?				
	4.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)?				
	4.4. Is there an acceptable response rate (60% or above)?				
5. Mixed methods	5.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and quantitative aspects of the mixed methods question (or objective)?				
	5.2. Is the integration of qualitative and quantitative data (or results*) relevant to address the research question (objective)?				
	5.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results*) in a triangulation design?				
	Criteria for the qualitative component (1.1 to 1.4), and appropriate criteria for the quantitative component (2.1 to 2.4, or 3.1 to 3.4, or 4.1 to 4.4), must be also applied.				

*These two items are not considered as double-barreled items since in mixed methods research, (1) there may be research questions (quantitative research) or research objectives (qualitative research), and (2) data may be integrated, and/or qualitative findings and quantitative results can be integrated.

2

Scores for quality assessment of quantitative and qualitative papers

Quality ratings for quantitative studies included in the review

Authors and year of study	Overall quality rating	Is the sampling strategy relevant to address the quantitative research question?	Is the sample representative of the population under study?	Are measurements appropriate?	Is there an acceptable response rate? e.g. over 60%
Bissonnette *et al.* (2011)[5]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Chambers *et al.* (2013c)[15]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Dietrich and Wevers (2010)[88]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Farquhar *et al.* (2010)[18]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Gillett *et al.* (2012)[20]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Kocourkova *et al.* (2014)[33]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Peeraer *et al.* (2014)[34]	* (25%) Weak	Yes	No, as this is a cohort study with a relatively small sample that may not be representative of the general population	Cannot tell	Cannot tell
Shaulov *et al.* (2015)[44]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Umstad *et al.* (2013)[46]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Vélez *et al.* (2013)[47]	** (50%) Weak	Yes	No, as this was a case study of one clinic and the sample may not be representative of the Quebec population of women of reproductive age	Yes	Cannot tell
Sol Olafsdottir *et al.* (2009)[40]	**** (100%) Strong	Yes	Yes	Yes	Yes
Cook *et al.* (2011) [14]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Simonstein *et al.* (2014)[38]	** (50%) Weak	Yes	No, and the author admits that the study is limited in scope	Yes	Cannot tell
Rauprich *et al.* (2010)[79]	*** (75%) Moderate	Yes	Yes	Yes	No Four surveys were used in this study. Study 1: RR 41% Study 2: RR 27–67% Studies 3 & 4 The RR could not be calculated for these two surveys.
Steiner and Jukic (2016)[98]	*** (75%) Moderate	Yes	Yes	Yes	Cannot tell
Vikström *et al.* (2015)[57]	*** (75%) Moderate	Yes	No	Yes	Yes
Záchia *et al.* (2011)[60]	*** (75%) Moderate	Yes	No	Yes	Yes

Quality rating for qualitative studies included in the review

	Overall quality rating	Are the sources of qualitative data relevant to address the research question?	Is the process for analyzing qualitative data relevant to address the question?	Is appropriate consideration given to how findings relate to the context e.g. the setting in which the data were collected?	Is appropriate consideration given to how findings relate to researchers' influence?
Birenbaum-Carmeli (2009)[4]	** (50%) Weak	Yes	Cannot tell	Cannot tell	No
Bretonnière (2013)[6]	**** (100%) Strong	Yes	Yes	Yes	Yes
Fournier *et al.* (2013)[92]	*** (75%) Moderate	Yes	Cannot tell	Yes	Yes
Gooldin *et al.* (2013)[21]	**** (100%) Strong	Yes	Yes	Yes	Yes
Hodgetts *et al.* (2012)[23]	**** (100%) Strong	Yes	Yes	Yes	Yes
Hodgetts *et al.* (2014)[25]	**** (100%) Strong	Yes	Yes	Yes	Yes
Silva and Barros (2012)[35]	*** (75%) Moderate	Yes	Yes	Yes	No
Street *et al.* (2011)[42]	*** (75%) Moderate	Yes	Yes	Yes	No

Appendix 6 Quality review of 'grey research' reports using AACODS and their results

AACODS

The **AACODS** checklist is designed to enable evaluation and critical appraisal of grey literature.

The Fourth International Conference on Grey Literature held in Washington, DC, in October 1999 **defined grey literature** as: "that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers."
Grey literature includes theses or dissertations (reviewed by examiners who are subject specialists); conference papers (often peer-reviewed or presented by those with specialist knowledge) and various types of reports from those working in the field. All of these fall into the **"expert opinion"**
Critical appraisal is "the process of carefully and systematically examining research to judge its trustworthiness, and its relevance and value in a particular context" (Burls 2009)

Grey (unpublished) studies and RCTs should be appraised using the same tools as their black (published) counterparts.

AACODS		YES	NO	?
Authority	Identifying who is responsible for the intellectual content. **Individual author:** • Associated with a reputable organisation? • Professional qualifications or considerable experience? • Produced/published other work (grey/black) in the field? • Recognised expert, identified in other sources? • Cited by others? (use Google Scholar as a quick check) • Higher degree student under "expert" supervision? **Organisation or group:** • Is the organisation reputable? (e.g. W.H.O) • Is the organisation an authority in the field? **In all cases:** • Does the item have a detailed reference list or bibliography?			
Accuracy	• Does the item have a clearly stated aim or brief? • Is so, is this met? • Does it have a stated methodology? • If so, is it adhered to? • Has it been peer-reviewed? • Has it been edited by a reputable authority? • Supported by authoritative, documented references or credible sources? • Is it representative of work in the field? • If No, is it a valid counterbalance? • Is any data collection explicit and appropriate for the research? • If item is secondary material (e.g. a policy brief of a technical report) refer to • the original. Is it an accurate, unbiased interpretation or analysis?			

Coverage	All items have parameters which define their content coverage. These limits might mean that a work refers to a particular population group, or that it excluded certain types of publication. A report could be designed to answer a particular question, or be based on statistics from a particular survey. • Are any limits clearly stated?			
Objectivity	It is important to identify bias, particularly if it is unstated or unacknowledged. • Opinion, expert or otherwise, is still opinion: is the author's standpoint clear? • Does the work seem to be balanced in presentation?			
Date	For the item to inform your research, it needs to have a date that confirms relevance • Does the item have a clearly stated date related to content? No easily discernible date is a strong concern. • If no date is given, but can be closely ascertained, is there a valid reason for its absence? • Check the bibliography: have key contemporary material been included?			
Significance	This is a value judgment of the item, in the context of the relevant research area • Is the item meaningful? (this incorporates feasibility, utility and relevance) • Does it add context? • Does it enrich or add something unique to the research? • Does it strengthen or refute a current position? • Would the research area be lesser without it? • Is it integral, representative, typical? • Does it have impact? (in the sense of influencing the work or behaviour of others)			

Quality assessment scores for grey research reports

The research reported in grey literature was quality appraised using the AACODS checklist. The checklist examines six major characteristics of each study: authority (author, organization, reference list), accuracy (aim, methods, peer review, credible data and sources), coverage (parameters and limits), objectivity (bias), date, and significance (relevance and context). Two of the reports were classified as strong and two as moderate.

Report	Authority	Accuracy	Coverage	Objectivity	Date	Significance	Total
ESHRE (2008)[49]	Yes 3/3	Partly 7/9	Yes 1/1	Yes 2/2	Yes 1/1	Yes 7/7	21/23 strong
IFFS (2013)[65]	Yes 3/3	Yes 9/9	Yes 1/1	Yes 2/2	Yes 1/1	Yes 7/7	23/23 strong
Präg *et al*. (2015)[66]	Yes 3/3	Partly 5/9	Yes 1/1	Yes 2/2	Yes 1/1	Partly 5/7	17/23 moderate
Council of Europe (2016)[67]	Partly 1/3	Partly 4/9	No 0/1	Yes 2/2	Yes 1/1	Partly 5/7	13/23 moderate

Appendix 7 Quality appraisal of NICE guidelines on infertility treatment

AGREE II instrument used to appraise the NICE guidelines

The overall objective(s) of the guideline is (are) specifically described.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The health question(s) covered by the guideline is (are) specifically described.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The guideline development group includes individuals from all relevant professional groups.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The views and preferences of the target population (patients, public, etc.) have been sought.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The target users of the guideline are clearly defined.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
Systematic methods were used to search for evidence.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The criteria for selecting the evidence are clearly described.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The strengths and limitations of the body of evidence are clearly described.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The methods for formulating the recommendations are clearly described.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The health benefits, side effects, and risks have been considered in formulating the recommendations.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
There is an explicit link between the recommendations and the supporting evidence.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The guideline has been externally reviewed by experts prior to its publication.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
A procedure for updating the guideline is provided.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The recommendations are specific and unambiguous.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The different options for management of the condition or health issue are clearly presented.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
Key recommendations are easily identifiable.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The guideline describes facilitators and barriers to its application.						
1. Strongly disagree	2.	3.	4.	5.	6.	7. Strongly agree
The guideline provides advice and/or tools on how the recommendations can be put into practice.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**

The potential resource implications of applying the recommendations have been considered.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The guideline presents monitoring and/or auditing criteria.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
The views of the funding body have not influenced the content of the guideline.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**
Competing interests of guideline development group members have been recorded and addressed.						
1. Strongly disagree	2.	3.	4.	5.	6.	**7. Strongly agree**

Adapted from Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, Fervers B, Graham ID, Grimshaw J, Hanna SE, Littlejohns P, Makarski J and Zitzelsberger L for the AGREE Next Steps Consortium (2010) AGREE II: advancing guideline development, reporting and evaluation in health care. *Canadian Medical Association Journal*, 182(18): E839–E842. doi: 10.1503/cmaj.090449

We strongly agreed with 20 of the 23 items in the AGREE II instrument; the three items we did not strongly agree with are in red font. This means that overall we have rated the guidelines of the highest possible quality.

Rate the overall quality of the guideline						
1. Lowest possible quality	2.	3.	4.	5.	6.	7. Highest possible quality

Appendix 8 Peer-reviewed journal descriptions of policy and social context for assisted reproductive technologies

Country	Policy and social context
Australia	Australia is regarded as following a liberal but safe assisted reproductive technology programme.[8] There are no limitations on age,[16, 43, 51] number of cycles or existing children.[9] Couples in stable relationships, singles and lesbians are allowed access to assisted reproductive technologies.[65] Australia promotes a policy of single-embryo transfer.[8] It also screens for child protection issues. Between 2002 and 2004, all intrauterine inseminations and in vitro fertilizations were partially funded through Australia's Medicare programme; between 2004 and 2009, once patients' annual out-of-pocket payments had reached an annual threshold, 80% of all future costs were funded through its Extended Medicare Safety Net programme; and since 2010, out-of-pocket expenses have increased by approximately four times for fresh cycles of in vitro fertilization and by three times for frozen cycles. This last change was the result of a cap on the rebate due to users, and was done in an attempt to control charges by medical specialists who seemed to increase their fees in the knowledge that the government would absorb the cost of the fee increases. For every dollar paid out in Extended Medicare Safety Net subsidies, 78% (on average) went to providers and only 22% to help patients with their out-of-pocket expenses.[9,43] The government introduced the cap to create a more sustainable approach to funding. The public seemed to prefer controls on expenditure rather than age limits or limits on the number of cycles.[43]
Bulgaria	Balabanova and Simonstein[1] describe Bulgaria as a paternalistic and pronatal society. They state that Bulgarian society generally views women as inferior to men, citing that women are paid less than men for doing the same job. It is also a common view that women are not complete until they have children, and women without children are viewed with suspicion. Social life and family events revolve around children. Contraception is only available through private healthcare services and out-of-pocket payments. Since the break-up of the Soviet Union, working conditions and child care availability are not conducive to having a family, so many women delay pregnancy, thereby increasing the need for assisted reproductive technology.[1]
Nordic countries in 2004	Olafsdottir and colleagues[40] state that equal rights to health services for all citizens is the cornerstone of the five Nordic countries' health policies. These rights are enshrined in legislation and the model of healthcare is based on social solidarity. Infertility treatment and artificial reproductive technologies have been funded since the 1980s and 1990s depending on the country. There is both public and private provision of assisted reproductive technology treatments in these countries. There is some sort of subsidy (payment through the tax system) for assisted reproductive treatment in each country and for both public and private provision. Each Nordic country has its own subsidy model, which imposes specific restrictions that make only certain couples eligible. The distance from clinics was consistently found to be a factor

Country	Policy and social context
	influencing costs and access for patients in all five countries.
Denmark	Up until mid-2010, Denmark was one of six countries that provided full funding for assisted reproductive technologies.[12] In June 2010, the Danish Government signalled its desire to cut funding for assisted reproductive technologies, with the aim of passing on a greater share of the costs to couples seeking care. The out-of-pocket payments increased by 500%, from €318 to €1,840.
Finland	In Finland,[27 13] over 60% of in vitro fertilization treatments are provided in the private sector, and women from the highest socioeconomic position are over-represented in the private sector. In spite of the reimbursement of private services, the private expenditure remains higher, i.e. more of women's own financial resources are needed for treatments in the private sector compared to the public sector. The use of private services is likely to create unfairness, but the unfairness in Finland is less than in countries where in vitro fertilization is not covered by health insurance, e.g. the UK.
France	Assisted reproductive technologies are regulated in France through the bioethics law of 1994. This law was revised first in 2004 and again in 2011.[6] In France there is a desire for all (including single people and same-sex couples) to be eligible for assisted reproductive technologies. Proponents (patient organizations and individauls) of wider access to assisted reproductive technologies argue that doctors and lawyers should not have a say regarding who can and cannot avail of assisted reproductive technologies.
Germany	The policy seems pragmatic and based on affordability. In 2004, with rising healthcare costs and the need to prioritize resources, infertility was considered a low priority and public funding subsidies for in vitro fertilization and intracytoplasmic sperm injection were cut from 100% of the total cost to 50%.[22]
Israel	Balabanova and Simonstein[1] describe Israel as a paternalistic and pronatal society. Government policy promotes the ideology of producing children and exercises strong social controls on women's bodies. In Israel, childlessness is viewed as a tragedy for both women and men, and childbirth as a female success. Israel has free maternity care, protects pregnant women who have just had a baby from redundancy, and provides maternity leave.[4] However, family planning does not receive state support and abortion is only allowed in limited circumstances.[1] A number of authors note that political, religious and demographic beliefs reinforce the need for Israelis to reproduce, in particular Jews.[1, 4] One author found that the policy language is inclusive of others and has the potential to benefit Arabs and homosexual men, and goes on to say that this has the potential to unite Jews and other minorities around a single issue.[21] Assisted reproductive technology (in particular in vitro fertilization and intracytoplasmic sperm injection) is seen as the solution to infertility; donor insemination is not encouraged and it is preferred that women go through in vitro fertilization or intracytoplasmic sperm injection rather than donor insemination so as to conceal male infertility.[4] The unlimited availability of in vitro fertilization cycles in Israel obliges women to continue with in vitro fertilization even if it has failed on a number of previous attempts, and this reinforces a culture of perseverance or persistence.[1, 37] Balabanova and Simonstein[1] note a number of in vitro fertilization-related side-effects such as

Country	Policy and social context
	weight gain, stress, marriage break-up, lack of sexual intimacy and damage to career due to sick leave. In addition, Birenbaum-Carmeli[4] reports higher rates of caesarean section deliveries and increased costs due to multiple births, and notes that side-effects of in vitro fertilization are downplayed. Simonstein has noted literature that details a possible link between cancer and in vitro fertilization.[37] In 2010, 4.2% of births were as a result of in vitro fertilization,[38] an increase from 2.6% in 2000, and this rise was attributed to the increased number of funded cycles per woman. However, the average success rate remained constant at between 15% and 17% of live births per cycle, raising questions about the advisability of unlimited cycles.
New Zealand	Since 2004, New Zealand has provided a reasonably liberal but safe assisted reproductive therapy programme. The purpose of the publicly funded programme has been to 'optimise preganancy outcomes'. .[18] Each applicant has to go through a rigorous clinical prioritization process before the clinician decides whether the applicant is suitable or not for treatment and, if suitable, which is the most suitable treatment. Each successful applicant can have a maximum of two cycles of treatment.
Portugal	The World Health Organization established as a global goal for the new millennium the improvement of women's access to infertility treatment and the availability and affordability of infertility services. In response to this directive, medically assisted reproduction has been a major issue in the recent structural reforms of the Portuguese health sector. Since 2006, Portugal has implemented several initiatives to scale up access and to improve affordability. However, inequalities in access persist; for example, no insurance coverage for infertility treatment, geographic concentration of services, proliferation of services in the private sector and restriction to heterosexual couples only. The main arguments used by public sector providers to justify restrictions on the number of treatments and eligibility criteria are inadequate human health resources, limited physical space, inadequate infrastructure and long wait times.[35]
Romania	Assisted reproductive technologies are neither regulated nor covered by the national healthcare system, except for a 2011 Ministry of Health pilot programme for married couples who were infertile for at least two years and had no living children.[6] The woman must be aged between 24 and 40 years and have healthy ovaries.[6] Assisted reproductive technologies are also available at private (profit-making) clinics and the criteria for accessing the technologies are heterogeneous. Separately, in 2005 and 2011 there were failed attempts to pass bills on assisted reproductive technologies.[6] Doctors are very powerful in Romania and do part of their training in France.

Appendix 9 Extraction table for Question 3: Criteria for accessing public funding for assisted reproductive technologies

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
Austria	Yes[49]	Yes.[49] Heterosexual couples.[3] Marriage and stable relationship in law and guidelines.[65]	No, in law[3, 49] <40 years[3, 16]	No, in law[49] <50 years[3]	Yes[3] and level of coverage linked to infertility diagnosis.[16]	No[49]	No information
Australia	Yes, entitlement to Medicare[65]	Stable relationship, singles and lesbians allowed.[65]	No age limit[16, 43, 51]	No information	No information	Yes, welfare of offspring paramount importance. Individuals considered to be unsuitable parents can be refused treatment.[65]	No information
Belgium	Yes[49]	No.[3, 49] All allowed in law.[3, 65]	Yes. [3, 49] <45 years in law[3] <40 years in practice[3] <43 years[16]	No[49]	Not in law.[3] Yes, in practice.[3]	No[49]	Yes, not mentioned in detail, only in general terms.[65]
Bulgaria	Yes[49]	No.[49]	Yes[49]	No[49]	No information	No[49]	No information

Country	Fulfil criteria to access publicly funded treatment	Criteria: Civil or marital status (married or living together for a defined period)	Maximum age for woman	Maximum age for man	Only provided for those with medical indication	Welfare of any future child (prospective parents' HIV status, criminal record, child protection)	Other medical issues or morbidities
		All allowed in law.[65]	18 to 40 years[1]				
Canada (Ontario)	Yes.[70] All those with Ontario health cards[70] and a primary care referral.	Available to eligible Ontarians regardless of sex, gender, sexual orientation or family status.[70]	Yes.[70] <43 for in vitro fertilization.[70]	No information	No, open to eligible patients with medical or non-medical infertility.[70]	No information	Access to fertility preservation, such as egg and sperm preservation, will be offered to people for medical reasons only, such as people who will undergo cancer treatment and who may be at risk of infertility in connection with that treatment.[70]
Croatia	No information	Marriage or stable relationship required in law.[65]	No information	No information	No information	No information	No information
Cyprus	No criteria, as no publicly funded	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
	service.[49]						
Czech Republic	Yes[49]	Yes.[49] Marriage or stable relationship required, in law.[65]	Yes[49]	No[49]	No information	No[49]	No information
Denmark	Yes[49]	No.[3, 49] All allowed in law.[3, 65]	Yes.[3, 49] <45 years in law.[3] <40 years in practice.[3, 16]	No[49]	No[3]	No.[49] After birth, the welfare of the child is followed in the Danish birth register.[65]	No information
Estonia	Yes[49]	No[49]	Yes[49]	No[49]		No[49]	No information
Finland	Yes[49]	Yes.[49] All allowed in law.[3, 65] Marriage not required.	Yes in practice.[49] None in law.[3] No age restrictions in practice.[16]	No[49]	No[3]	No.[49] Yes, some limitations to the provision of assisted reproductive technology are based on the consideration of the welfare of the child.[65]	No information
France	Yes[49]	Yes.[49] Heterosexual couples.[3, 92] Stable	Yes.[3, 49] Childbearing age[3, 92] <43 in practice.[3, 16]	Yes[49]	Yes[3, 92]	No,[49] in law and regulation. Doctors can decide on an individual basis who cannot	No information

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
		relationship in law and guidelines.[65] Marriage not required.				have assisted reproductive technology in the interests of any potential child.	
Germany	Yes[49]	No [16, 49] in earlier references. Yes (married)[79] for statutory health insurance fund.[67] Heterosexual couples[3] in *de facto* relationships for central fund.[67]	None in law.[3, 16] Yes,[49] in practice <40 years.[3, 16, 79]	No.[49] <50 years.[3, 79]	Yes.[3] No previous male sterilization.	No.[49]	HIV positive and not treated.[79]
Greece	Yes[49]	Yes.[49] Not in law.[3] Stable relationship in law.[65]	Yes.[3, 49] <50 years.[3]	No[49]	Not in law.[3] Yes, in practice.[3]	No[49]	No information

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
		Single allowed in law.[65] Marriage not required.					
Hungary	Yes[49]	Yes.[49] Married, stable relationship or single allowed in law.[65]	No[49]	No[49]	No information	No[49]	No information
Iceland	Not clear whether public funding is available or not.	Marriage or cohabitation in law.[40]	Yes, 42 in practice and 45 years in law.[40]	Yes, 50 years in law.[40]	No information	No information	No information
Israel	Yes	Married, stable relationship and singles allowed in law and guidelines.[65]	<46 years.[16] Up to 44 years if she uses own eggs.[4] Up to 51 years if she uses a donor egg.[4] Up to 45 years if she uses own eggs.[4, 21] Up to 54 years if she uses a donor egg[94]	No information	No information	No information	No information
Italy	Yes[49]	Yes.[3, 49]	Yes.[3, 49]	No[49]	Yes[3]	No.[49]	No information

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
		Heterosexual couples.[3] Married and stable relationship allowed in law and guidelines.[65]	Childbearing age.[3, 16]			Legal status [of ART child] after birth. Article 8 of Law 40/2004 equalizes them to legitimate offspring conceived naturally.[65]	
Latvia	No[49] Yes[65] Change of status in later publication	Not applicable.[49] All allowed in law.[65]	Not applicable.[49] <38 years.[65]	Not applicable.[49]	No information	Not applicable.[49] Legal status after birth.[65]	No information
Lithuania	No criteria, as no publicly funded service.[49]	Not applicable[49]	Not applicable[49]	Not applicable[49]	Not applicable	Not applicable[49]	Not applicable
Luxembourg	Yes[49]	No[49]	Yes[49]	No[49]	No information	No[49]	No information
Malta	No criteria, as no publicly funded service.[49]	Not applicable[49]	Not applicable	Not applicable[49]	No information	Not applicable[49]	No information
Netherlands	Yes[49]	No.[3, 49] All allowed.[3]	Yes[3, 49] <45 years[3, 16]	No[49]	Yes[3]	No[49]	No information
New	Yes[73]	All allowed in	Not specified but	Not	People/couples	Yes, health and well-being of	Women should be

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
Zealand[73]		law.[65] Exclusions that breach Human Rights Act or Bill of Rights Act are not permitted.[93]	the age of the female partner reflects the probability of conceiving with therapy and is a consideration in the weighting of the points awarded under the priority criteria scoring.[93] Since 1999, funding is restricted to those <40 years old.[16, 18] <40 years scores 10 points on clinical priority access criteria, while being aged between 40 and 41 scores five points and being	mentioned[7] [3]	eligible for publicly funded health services must also meet the eligibility criteria for the assisted reproductive technology service: inability to achieve pregnancy after at least one year of unprotected intercourse to attempt pregnancy; having biological circumstances	children 'an important consideration'.[65] Access is refused if there are situations that compromise the safety of couple or child.[93] Having children or a previous sterilization will contribute negatively to the priority criteria.[93]	non-smoking and nicotine free for three months.[18, 93] Women with a BMI higher than 32kg/m^2 should be given a stand down period and classified as 'active review' to see if they can achieve a lower BMI, and a weight improvement programme should be instituted before treatment is begun.[93] Adequate ovarian reserve.[93] Women with hydrosalpinges should be treated prior to in vitro fertilization or intracytoplasmic

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
			aged 42 only scores one point.[20]		that prevent them from attempting pregnancy; inability to carry a pregnancy to term; being at risk of passing to their children a familial single gene disorder, a familial sex-linked disorder, or familial chromosomal disorder; being about to undergo publicly funded clinical treatment (such		sperm injection.[93]

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
					as cancer treatment) that may permanently impair their future fertility, and who are likely to survive that treatment and who have not previously had children.[73]		
Norway	Yes[65]	Married, stable relationship, and lesbians allowed in law.[65]	No information	No information	No information	No information	No information
Poland	No[49] Yes[63] Change of status at later date.	Not applicable.[49] Married couples.[63]	Not applicable[49] <40 years[63]	Not applicable[49]	Infertility[63]	Not applicable[49]	No information
Portugal	Yes[49]	Yes.[3, 49] Heterosexual	Yes.[49] Not in law.[3]	No	Yes[3]	No	No information

		Criteria					
Country	**Fulfil criteria to access publicly funded treatment**	**Civil or marital status (married or living together for a defined period)**	**Maximum age for woman**	**Maximum age for man**	**Only provided for those with medical indication**	**Welfare of any future child (prospective parents' HIV status, criminal record, child protection)**	**Other medical issues or morbidities**
		couples.[3]	National health service criteria:[35] First line treatment for women under 42 years. Second line treatment for women under 40 years. Not clear what first and second line treatment refers to.				
Romania	No criteria, as no publicly funded service.[49]	Not applicable[49]	Not applicable[49]	Not applicable[49]	Not applicable	Not applicable[49]	Not applicable
Russia	Yes[65]	Married, stable relationship or single allowed in law[65]	No information	No information	No information	No information	No information
Slovakia	No written criteria[49]	No written criteria[49]	No written criteria[49]	No written criteria[49]	No written criteria[49]	No written criteria[49]	No written criteria[49]
Slovenia	Yes[49]	Yes.[49] Stable	Yes[49]	No[49]	No information	No.[49] Yes, the best interest of the	No information

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		relationship in law.[65] Marriage not required.				child should be respected in infertility treatment.[65] Change of status at later date	
Spain	Yes[49]	No.[3, 49] All allowed in law[3, 65]	Yes, in practice.[49] Not in law.[3, 16] Childbearing age 'soft'.[3]	No[49]	Not in law.[3] Yes, in practice.[3]	No[49]	No information
Sweden	Yes[49]	Yes.[49] Both heterosexual and homosexual couples.[3] Married Stable relationship and lesbians allowed in law.[65] Single women can access assisted reproductive	Yes.[3, 49] Childbearing age.[3, 16]	Yes[49]	Yes[3]	Yes, parents (to be) should not be too old or sick and of reasonably good psychosocial status to ascertain a reasonably smooth childhood.[65]	No information

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		services since April 2016.[67]					
Switzerland	No public funding	For private funding: Stable relationship allowed in law.[65] Marriage not required.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
UK England	Yes[49]	None.[3, 49] All allowed in law.[3, 65]	Yes.[49] Not in law.[3] <40 years in practice.[3] NICE recommends that in vitro fertilization should be offered to women up to 42 years of age with certain criteria to be met.[80] If women aged	No[49]	Not in law.[3] Yes, in practice.[3] NICE recommends that couples who have been trying to get pregnant through regular unprotected sex for two years, or who have	Yes.[49] Yes, in accordance with HFEA Code of Practice, a woman shall not be provided with treatment services unless account has been taken of the welfare of any child who may be born as a result of the treatment (including the need of that child for supportive parenting) and of any other child who may be affected by the birth.[65]	The Department of Health has approved a set of standardized access criteria for NHS fertility treatment developed by the patient support organization Infertility Network UK.[78] Some CCGs apply additional criteria that affect access to NHS-funded in vitro fertilization

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			under 40 years who have not conceived reach the age of 40 during treatment, complete the current full cycle but do not offer further full cycles.[80] For women aged 40–42 years who have not conceived offer one full cycle of in vitro fertilization, with or without intracytoplasmic sperm injection, provided the following three criteria are fulfilled: they have never		had 12 cycles of artificial insemination, are suitable.[80]		treatment. This includes the woman: being a healthy weight (BMI range of 19–30); not smoking; not having children from this or any previous relationships; being within specific age ranges (some CCGs will only fund women aged under 35 years).[78] The NHS advise that maintaining a healthy weight and avoiding alcohol, smoking and caffeine during treatment may improve your chances of having a baby with

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			previously had in vitro fertilization treatment; there is no evidence of low ovarian reserve; there has been a discussion of the additional implications of in vitro fertilization and pregnancy at this age.[80]				in vitro fertilization.[78]
UK Scotland	Yes, and all boards follow the same criterion since 2013.	Heterosexual and homosexual couples cohabiting for two years or more.[75, 81] No individual (male or female) can access more than the	Up to 40 years (fresh cycles) and completed by 41st birthday (frozen cycles).[75, 81] For couples where the woman is aged from 40 to 42 years, one full cycle will be offered if: they have	No information	Yes. Infertility with an appropriate diagnosed cause of any duration, or unexplained infertility of at least two years' duration, or six	Neither partner previously sterilized.[75 81,] No child living with the couple in their home (under review). Up to 2013, only couples without children were eligible for assisted reproductive technology.[81] National Infertility Group	Obesity; BMI must be >18.5 and <30.[75, 81] Non-smoking three months prior to and during treatment.[75, 81] Abstain from alcohol and other drug consumption.[75, 81] Not prescribed an opiate substitute for

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		number of NHS-funded in vitro fertilization treatment cycles supported by NHS Scotland under any circumstances, even if they are in a new relationship.[75, 81]	never previously had in vitro fertilization treatment; there is no evidence of poor ovarian reserve and if, in the treating clinician's view, it is in the patient's interest; there has been a discussion of the additional implications of in vitro fertilization and pregnancy at this age.		to eight cycles of donor insemination for same-sex couples.[81] NHS funding may be given to those patients who have previously paid for in vitro fertilization treatment if, in the treating clinician's view, the individual clinical circumstances warrant further treatment.[75, 81]	Report 2013 recommends couples may be suitable for in vitro fertilization if one partner has no genetic children and the couples meet all other criteria after 2015.[81]	one year prior to treatment.[75, 81] Adequate ovarian reserve.[75]
UK Wales	Yes.	All who meet	Women aged under	No	IVF on the NHS	No information	Patients must have a

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	Criteria were to be reviewed in September 2014.[75] Follow NICE recommendations; however, health boards may have additional criteria you need to meet before you can have in vitro fertilization on the NHS, such as not having any children already, from both your current and any previous relationships.[95]	criteria including single women and men.[75]	40 years. Women aged between 40 and 42 years who meet the access criteria are entitled to one cycle of in vitro fertilization or intracytoplasmic sperm injection (in line with NICE guidance) provided that they meet the following criteria: the patient has never previously had in vitro fertilization treatment; there is no evidence of low ovarian reserve; there has been a discussion of the additional	information	in Wales is available for couples who do not have any living children (biological or adopted) or where one of the partners does not have any living children (biological or adopted).[75]		BMI score of 19 to 30 (inclusive).[75] Follow NICE recommendations; however, health boards may have additional criteria you need to meet before you can have IVF (being a healthy weight; not smoking, drinking below low-risk limits; taking folic acid; regular cervical smear; regular health checks).[95]

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			implications of in vitro fertilization and pregnancy at this age.[75] Follow NICE recommendations; however, health boards may have additional criteria that you need to meet before you can have in vitro fertilization if you are in a certain age range.[95]				

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