FRIDA GYLLENBERG

LONG-ACTING REVERSIBLE CONTRACEPTION FREE OF CHARGE: INITIATIONS, USER CHARACTERISTICS AND INDUCED ABORTIONS

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Long-Acting Reversible Contraception Free of Charge: Initiations, User Characteristics, and Induced Abortions

Frida Gyllenberg
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<tr>
<td>ACA</td>
<td>Affordable Care Act</td>
</tr>
<tr>
<td>ACOG</td>
<td>The American College of Obstetricians and Gynecologists</td>
</tr>
<tr>
<td>AIC</td>
<td>Akaike Information Criterion</td>
</tr>
<tr>
<td>aOR</td>
<td>Adjusted Odds Ratio</td>
</tr>
<tr>
<td>aRR</td>
<td>Adjusted Rate Ratio</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>Cu-IUD</td>
<td>Copper intrauterine device</td>
</tr>
<tr>
<td>DHS</td>
<td>Demographic and Health Survey</td>
</tr>
<tr>
<td>DMPA</td>
<td>Depot medroxyprogesterone acetate</td>
</tr>
<tr>
<td>ENG</td>
<td>Etonogestrel</td>
</tr>
<tr>
<td>EHR</td>
<td>Electronic health records</td>
</tr>
<tr>
<td>HR</td>
<td>Hazard ratio</td>
</tr>
<tr>
<td>IUC</td>
<td>Intrauterine contraception</td>
</tr>
<tr>
<td>LARC</td>
<td>Long-acting reversible contraception</td>
</tr>
<tr>
<td>LNG</td>
<td>Levonorgestrel</td>
</tr>
<tr>
<td>LNG-IUS</td>
<td>Levonorgestrel-releasing intrauterine system</td>
</tr>
<tr>
<td>MEC</td>
<td>Medical Eligibility Criteria</td>
</tr>
<tr>
<td>NHS</td>
<td>National Health Services</td>
</tr>
<tr>
<td>NICE</td>
<td>National Institute for Health and Clinical Excellence</td>
</tr>
<tr>
<td>NSFG</td>
<td>National Survey of Family Growth</td>
</tr>
<tr>
<td>OR</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>PID</td>
<td>Pelvic inflammatory disease</td>
</tr>
<tr>
<td>PY</td>
<td>Person-years</td>
</tr>
<tr>
<td>RR</td>
<td>Rate Ratio</td>
</tr>
<tr>
<td>RR</td>
<td>Rate Ratio</td>
</tr>
<tr>
<td>SPR</td>
<td>Selected practice recommendations</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>US</td>
<td>United States</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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ABSTRACT

Long-acting reversible contraception (LARC) methods are the most effective methods in preventing unintended pregnancy. LARC methods include intrauterine devices, contraceptive implants, and injectables, and do not require any daily tasks from the user. Hence, these methods are as effective in practical use as at their theoretical best. Expert organizations advocate the use of LARC methods as a first-line choice for all women, as these methods are not only effective but also safe and cost-effective. However, on the global scale, there are many barriers to LARC use. These include lack of patient and provider awareness, high up-front costs, and misconceptions about safety. For this reason, in most Western countries, these methods are not as widely used as short-acting methods. Programs addressing these barriers and promoting LARC have been evaluated, but little is known of the effects of a public program providing LARC methods free of charge on the population level.

This thesis evaluates the effects and characteristics of a public LARC program in the City of Vantaa in the Helsinki Metropolitan Area of Finland. In Vantaa, rates of induced abortion were for a long time higher than both national and regional levels. In January 2013, a public program was launched aiming at preventing unintended pregnancies and thus reducing rates of induced abortions. This program offered all women their first LARC method free of charge at public family planning clinics. These clinics have been in place since the 1970s, with well-established services, and they are frequently used by the local population. When the LARC program started, the only new benefit was the provision of free-of-charge LARC methods, while all other services, legislation, and access regarding induced abortion remained unchanged.

For this thesis, a new population cohort was established. The complete study population comprised all women living in Vantaa in 2013–2014 aged 15–44 years who were eligible for free-of-charge LARC, almost 50,000 women in total. Eligibility was defined as not having a LARC initiation or removal at public clinics since 2000. All women using public contraceptive services during the first two years since the beginning of the public LARC program were identified (9,669 women), as were all women who initiated a LARC method free of charge (2,035 women). The cohort participants were monitored by means of national registers to identify all the pregnancies that had started before February 28th, 2016.

This dissertation consists of three articles. The first article describes factors predicting the initiation of a free-of-charge LARC method among those eligible. A history of delivery increased the odds for initiating a free-of-charge LARC method in all age groups (odds ratio [OR] 5.39, 95% confidence interval [CI] 4.69–6.19). A history of induced abortion was also associated with initiation (OR 1.39, 95% CI 1.21–1.56), but in age-stratified models, this association was only present among women younger than 25 years of age. Other factors significantly associated with LARC initiation were being 20–24 years old (OR 1.25, 95% CI 1.07–1.47), being
married (OR 1.23, 95% CI 1.08–1.40), and not having used public family planning clinic services within two years before this study (OR 1.31, 95% CI 1.17–1.46).

The second article assesses the need for induced abortion during follow-up among women eligible for a free-of-charge LARC method. Altogether, 78,500 person-years were monitored, and the mean follow-up time was two years. Women initiating and those not initiating LARC methods at public family planning clinics were compared. In addition, both groups were compared with age-matched population controls from the complete study population not using public family planning services. The rate of induced abortions was 80% lower among women who initiated free-of-charge LARC compared to women not initiating a LARC method, despite being eligible for one free of charge (adjusted rate ratio [aRR] 0.20, 95% CI 0.11–0.32). Furthermore, the rate of induced abortions was more than 70% lower among women initiating LARC methods than among their population controls (aRR 0.26, 95% CI 0.14–0.43). However, there was no difference in the rate of induced abortions among women using public family planning services but not initiating a free-of-charge LARC as compared to their population controls (aRR 1.01, 95% CI 0.87–1.18).

In the third study, times series methods were used to investigate the effects of the public program on the population level. The step change in monthly mean rates of LARC initiations was assessed, adjusting for confounders on the aggregated level. A significant increase in the rate of LARC initiations was identified in all age groups: almost four-fold among 15–19-year-olds and approximately two-fold among 20–44-year-olds. The time series of induced abortions in the neighboring municipality of Espoo was included when evaluating the change in monthly mean rates of induced abortions to control for possible concurrent events affecting the local rates of induced abortions. These analyses revealed a reduction in the rates of induced abortions of 36% among 15–19-year-old women (aRR 0.64, 95% CI 0.54–0.74) and of 14% among 20–24-year-old women (aRR 0.85, 95% CI 0.74–0.96). The modest reduction in rates of induced abortions seen among 25–44-year-olds was not statistically significant (aRR 0.94, 95% CI 0.84–1.03).

To conclude, the public program in Vantaa reached women with a history of induced abortion and delivery well. The program was associated with a reduced need for induced abortion assessed by both survival analysis on the individual level and with time series analysis on the aggregated level. Thus, the free-of-charge program addressed an unmet need for family planning services in the population. In addition, the program was cost-effective among women under 25 years of age.
LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:


The publications are referred to in the text by their Roman numerals. The original publications are reproduced with the permission of the copyright holders.
In the United Nations (UN) Millennium Declaration, the UN set up a range of goals that member states agreed on. These goals addressed poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. The 5th goal was set as to Improve maternal health and the goal was further specified as Reducing maternal mortality by three fourths and achieving universal access to reproductive health. While the deadline has passed, the work continues under UN guidance with the Sustainable Development Goal 5.6, defined as to Ensure universal access to sexual and reproductive rights.

Although there are substantial challenges in fighting maternal mortality, one entirety is essentially preventable: maternal mortality caused by unintended pregnancy. Specifically, the aforementioned deaths could have been avoided if effective contraception would have been used. The contraceptive methods are described as either traditional or modern. Traditional methods comprise rhythm or calendar methods and withdrawal, whereas modern methods comprise the permanent methods of male and female sterilization, condoms, long-acting reversible methods such as intrauterine devices, contraceptive implants, and injectables, and short-acting methods such as oral contraceptives, patches, and rings. Lactational amenorrhea is sometimes considered a modern method, together with vaginal barrier methods and emergency contraception.

While childbearing, delivery, and induced abortion are generally safe in developed parts of the world, it has been estimated that in 2012 alone, contraceptive methods averted 118,000 maternal deaths. If all need for family planning had been met in the developing world in 2012, an additional 80,000 maternal deaths would have been averted (Singh and Darroch, 2012). According to another estimation, maternal mortality could be reduced by one-third if all unmet need for family planning was fulfilled (Ahmed et al., 2012). Thus, fighting maternal mortality should always include addressing the unmet need for family planning.

The unmet need for family planning is defined as the proportion of women of reproductive age – either married or living in a union – who want to prevent or postpone pregnancy but do not use any contraceptive method (Singh and Darroch, 2012). According to a recent UN report on global contraception use, up to 48% of women aged 15–49 use contraception (either modern or traditional methods). Meanwhile, an estimated 10 percent of women worldwide who want to prevent pregnancy – in other words, 190 million women – do not use any kind of contraception, despite being sexually active. These women present an unmet need for family planning (United Nations, 2019a).

With millions of women having an unmet need for family planning, rates of unintended pregnancy are concurrently high. It is estimated that up to 40% of
all pregnancies worldwide are unintended (Sedgh et al., 2014). The rate of unintended pregnancy is reflected in the rate of induced abortions, which has been declining in the developed world since the 1990s, while remaining stable in developing parts of the world (Singh et al., 2018). In the most recent estimations by the Guttmacher Institute, the rate of induced abortions was reported as 27 induced abortions among 1000 women aged 15–49 in developed parts of the world and 36/1000 in developing regions (Singh et al., 2018), although data on induced abortions is susceptible to incomplete national statistics, especially in areas with restrictive laws (Singh et al., 2019).

There is no information on the rates of unintended pregnancy in Finland, but rates of induced abortion are low when compared to global, European, and even Nordic levels. The rate of induced abortions in Finland has not exceeded 10 induced abortions per 1000 women aged 15–49 years since 2000 (Heino and Gissler, 2019). However, there is considerable variation between municipalities within Finland. In the City of Vantaa in the Helsinki Metropolitan Area, rates of induced abortion for long remained above the national level, steadily standing above 10/1000 women, even while the abortion rates in neighboring cities declined. Based on an initiative by general physicians and nurses working at the public family planning clinics in Vantaa, a public program providing all women in Vantaa with the option to receive her first long-acting reversible contraceptive method (LARC) free of charge was designed. The program was implemented at all public family planning clinics in Vantaa in January 2013.

This thesis explores the public program entitled women in Vantaa, Finland, to their first LARC method free of charge. The findings concerning user characteristics, induced abortions among women initiating LARC methods, and the estimates of population-level effects on LARC uptake and induced abortion could be of importance when designing public services both in Finland and abroad.
2 REVIEW OF THE LITERATURE

This literature review aims to present and summarize relevant scientific research on family planning, with a special focus on long-acting reversible contraception (LARC), user characteristics of LARC, contraceptive service delivery systems, and public programs promoting LARC, starting with a brief overview of unintended pregnancy. Although unintended pregnancy is a global concern, the settings providing services that aim to reduce unintended pregnancy are very different in developed vs. developing countries. Therefore, contraceptive use, service delivery, and reimbursement of contraceptives are reviewed with a focus on research conducted in developed countries.

2.1 UNINTENDED PREGNANCY

Unintended pregnancy – ending in either induced abortion or unplanned birth – has been found to affect the mental and physical well-being of both the mother and child (Gipson et al., 2008). Thus, unintended pregnancy is considered a major public health challenge, and reducing the rates of these pregnancies an important goal for public health policies (Eshre Capri Workshop Group, 2018).

2.1.1 DEFINITION AND MEASUREMENT

The most common definition of unintended pregnancy is a pregnancy that is either unwanted or mistimed, whereas an unplanned pregnancy is defined as a pregnancy that either starts when a woman is using contraception or is not trying to conceive but not using any method (Santelli et al., 2003). However, there is no consensus definition, and the terms unintended and unplanned are often used interchangeably.

The intendedness of pregnancy cannot be objectively measured, and a pregnancy is not always a product of a conscious decision (Aiken et al., 2016, Barrett and Wellings, 2002, Fischer et al., 1999, Moos et al., 1997). Information may thus be gathered from surveys on pregnancy intentions or estimated from statistics concerning sociodemographic characteristics, such as marital status. However, marked discrepancies have been reported between answers to different surveys regarding pregnancy intentions (Kaufmann et al., 1997). One measurement for the intendedness of pregnancy is the London measure of unplanned pregnancy, which allows for mixed feelings about pregnancy, as it scores the pregnancy as unplanned on a scale from 0 to 12 (Box A) (Barrett et al., 2004, Barrett and Wellings, 2002, Morof et al., 2012, Wellings et al., 2013).
London measure of unplanned pregnancy
1. At the time of conception
   Always used contraception / Inconsistent use / Not using contraception
2. In terms of becoming a mother
   Wrong time/ OK but not quite right / Right time
3. Just before conception
   Did not intend to become pregnant / Changing intentions / Intended to become pregnant
4. Just before conception
   Did not want a baby / Mixed feeling about having a baby / Wanted a baby
5. Before conception
   Had never discussed children / Discussed but no firm agreement / Agreed pregnancy with partner
6. Before conception
   No actions / Health preparations (1 action) / Health preparations (2 actions)

Box A. Questions of the London measure of unplanned pregnancy, each with three answer choices rendering 0 (first option) to 2 (last option) points. A total of 0–3 points classifies the pregnancy as unplanned, 4–9 as ambivalent, and 10–12 as planned (Barrett et al., 2004).

2.1.2 RATES OF UNINTENDED PREGNANCY

Worldwide, an estimated 40% of all pregnancies are unintended, and the rate of unintended pregnancy is estimated to be higher in developing countries than in more developed regions (Bearak et al., 2018, Singh et al., 2010). However, data on the intendedness of pregnancy are always merely an estimation, and studies assessing unintended pregnancy may thus use the rate of induced abortion as a proxy for unintended pregnancy. However, this is not a perfect estimation, even in countries with liberal laws on induced abortion (Eshre Capri Workshop Group, 2018).

The proportion of unintended pregnancies ending in induced abortion is slightly higher in developed regions than in developing parts of the world (Figure 1A) (Bearak et al., 2018, Sedgh et al., 2014, Singh et al., 2018). Of note is that data on induced abortions may differ markedly from the true situation. The figures reported by the Guttmacher Institute are obtained by a theoretical approximation based on national and published data, producing estimated rates of induced abortion and unintended pregnancy with a 90% uncertainty interval (Singh et al., 2018). This approximation method is also evaluated as the most robust tool in estimating induced abortions for areas without reliable national statistics (Singh et al., 2019).
In Finland, the Register of Induced Abortions is well validated and a reliable source of information on induced abortions (Gissler et al., 1996, Heino et al., 2017). Compared to both global and Nordic figures, the rate of induced abortion in Finland is low (Figure 1B). In 2018, only 7.6 induced abortions were carried out per 1000 women aged 15–49 years (Heino and Gissler, 2019). The rate of induced abortion has steadily declined in Finland since the 1970s, when the current legislation on induced abortions came into effect. The decline has been especially pronounced among teenagers. However, the proportion of induced abortions performed among women with a history of induced abortion has been on the rise (Heino and Gissler, 2019).

### 2.2 MODERN CONTRACEPTION

Modern contraception became increasingly available in the 1960s, with the first contraceptive pill launched in 1960 and intrauterine contraception gaining popularity. The possibility to effectively prevent pregnancy was the cornerstone of the ‘first reproductive revolution’. The increased use of modern contraception was followed by declines in total fertility rates: in the 1960s, a woman had an average of five live births during her lifetime, but this number was cut in half during the following 50 years (Benagiano et al., 2007, United Nations, 2019c).
2.2.1 DEFINITION

The definition of modern contraception may vary between sources, as no consensus definition has been reached. In 2015, the experts Hubacher and Trussel defined modern contraception as “A product or medical procedure that interferes with reproduction from acts of sexual intercourse” (Hubacher and Trussell, 2015). The classification of contraceptive methods as modern and non-modern according to this definition is presented in Box B.

Today, a comprehensive selection of modern contraceptives is available on the market, with multiple routes of administration. Modern methods are further classified as hormonal and non-hormonal methods, reversible and permanent methods, and short-acting and long-acting methods, depending on the characteristics of the method (Table 1).

Table 1. Classification of modern contraception.

<table>
<thead>
<tr>
<th>Permanent vs. reversible methods</th>
<th>Hormonal vs. non-hormonal reversible methods</th>
<th>Short-acting vs. long-acting reversible methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent</td>
<td>Hormonal</td>
<td>Short-acting</td>
</tr>
<tr>
<td>Sterilization</td>
<td>LNG intrauterine systems</td>
<td>Oral contraceptives</td>
</tr>
<tr>
<td>Reversible</td>
<td>Subdermal implants</td>
<td>Patches</td>
</tr>
<tr>
<td>Intrauterine contraception</td>
<td>Oral contraceptives</td>
<td>Vaginal rings</td>
</tr>
<tr>
<td>Subdermal implants</td>
<td>Injectables</td>
<td></td>
</tr>
<tr>
<td>Oral contraceptives</td>
<td>EC pill</td>
<td>Long-acting</td>
</tr>
<tr>
<td>Injectables</td>
<td>Patches</td>
<td>LNG intrauterine system</td>
</tr>
<tr>
<td>EC pill</td>
<td>Vaginal rings</td>
<td>Subdermal implants</td>
</tr>
<tr>
<td>Patches</td>
<td>Non-hormonal</td>
<td>Injectables</td>
</tr>
<tr>
<td>Vaginal rings</td>
<td>Cu intrauterine devices</td>
<td></td>
</tr>
</tbody>
</table>

Note: Barrier methods not presented. Abbreviations: LNG: levonorgestrel, Cu: copper, EC: emergency contraception.
2.2.2 RECOMMENDATIONS AND GUIDELINES ON CONTRACEPTION

Prior to 1990, most recommendations on contraceptive use were based on expert opinions (Altshuler et al., 2015). In 1996, the World Health Organization released its first recommendation on medical eligibility for contraceptive use: *Improving access to quality care in family planning: medical eligibility criteria for contraceptive use*. This guidance aimed to increase evidence-based decisions regarding contraceptive use, remove non-scientific exclusion criteria, and improve the quality of contraceptive care. The medical eligibility criteria (MEC) comprise a four-category scale for how well the method is suited given a specific clinical condition. The categories can further be simplified into two categories: *use the method* and *do not use the method* depending on the setting of care (Table 2).

**Table 2.** Categories of eligibility in the WHO medical eligibility criteria recommendation.

<table>
<thead>
<tr>
<th>Category</th>
<th>With good resources for clinical judgement</th>
<th>With limited resources for clinical judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use method in any circumstances</td>
<td>Yes (Use the method)</td>
</tr>
<tr>
<td>2</td>
<td>Generally use the method</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Use of method not usually recommended unless other more appropriate methods are not available or not acceptable</td>
<td>No (Do not use the method)</td>
</tr>
<tr>
<td>4</td>
<td>Method not to be used</td>
<td></td>
</tr>
</tbody>
</table>

Reference: Medical eligibility criteria for contraceptive use, (WHO).

In 2002, WHO released the first *Selected practice recommendations for contraceptive use* (SPR). This report complements the WHO MEC with guidance on how to use contraceptives safely and effectively, among those eligible (Chen et al., 2017). WHO regularly updates both the medical eligibility criteria and the selected practice recommendations to reflect the most recent scientific evidence and knowledge, with the most recent release of WHO MEC in 2015 and of WHO SPR in 2016.

The WHO MEC is a global recommendation, and the clinical implementation may consequently vary in different parts of the world. Therefore, national guidelines and expert organizations provide recommendations and clinical guidelines based on the MEC recommendation but adapted to the country or region in question. Approximately 50 countries have adopted the WHO MEC into national guidelines and programs (Altshuler et al., 2015). For example, the Faculty of Sexual and Reproductive Healthcare has since 2006 published the UKMEK for use in the UK (Faculty of Sexual and Reproductive Healthcare, 2016). In the USA, the Centers for Disease Control...
and Prevention are responsible for adapting the recommendation for regional use (Centers for Disease Control and Prevention, 2016).

The first national guidelines on contraception in Finland were published in 2015 (Current Care Guidelines, 2015). However, the National Board of Health issued recommendations on the provision of family planning services in Finland from 1972 to 1982, with detailed descriptions of the responsibilities of the health care personnel, including evaluation of eligibility, contraindications for contraceptive methods, and contraceptive counselling (Rimpela et al., 1996). The first Finnish National Action Plan for Sexual and Reproductive Health was launched in 2007 and updated in 2013 (Klemetti and Raussi-Lehto, 2013).

### 2.2.3 PREVALENCE OF USE

The use of modern contraceptive methods rose as access increased. Today, an estimated 44% of women aged 15–49 years use modern contraception worldwide, according to recent UN data (United Nations, 2019a). The most commonly used method worldwide is reportedly female sterilization, whereas oral contraception is the most common method in Europe and North America.

In a study on five European countries in 2010, oral contraception was the method of choice for 30% of surveyed women, the male condom for 20%, LARC methods for 11%, and sterilization (male and female combined) for 11% (Skouby, 2010). The figures from the UK were slightly different in a more recent report from the National Health Services (NHS), where oral contraception accounted for 47% of modern contraceptive use, LARC methods for 31%, and the male condom for 18% (National Health Services, 2014).

A recent Nordic study evaluated the use of modern and reversible contraception in the Nordic countries based on prescription data and manufacturer sales figures (Lindh et al., 2017). The study revealed that Finland and Denmark had the highest prevalence of modern contraception use (40%), with combined oral contraception being the most common method in all countries (highest prevalence in Denmark: 26%), followed by LARC methods (highest prevalence in Sweden: 20%). In the USA, the most common methods reported by women aged 15–44 years were oral contraception (26%), female sterilization (25%), and the male condom (15%), according to results from a nationally representative survey (Daniels et al., 2015).

### 2.2.4 EFFECTIVENESS OF CONTRACEPTIVE METHODS

The efficacy of any medical or pharmaceutical intervention describes how well it works under ideal circumstances, such as in a clinical trial, whereas the effectiveness describes how well it works in real life (Haynes, 1999). Perfect use of contraception, i.e. reflecting the efficacy of the method, requires both
correct and consistent use, while the effectiveness in typical use reflects real life use and accounts for forgetting, flaws, and mistakes. Thus, the difference between efficacy and effectiveness describes how difficult the method is to use in real life – without loss of efficacy. The number of method failures, i.e. unintended pregnancies, during contraception use depends on pure method failures, user inaccuracy, and on the fertility and sexual behavior of the user (Trussell, 2011).

Methods that require ongoing efforts from the user show a significant difference between efficacy and effectiveness (Trussell, 2009). Natural and barrier methods require continuous adherence from the user, and short-acting hormonal methods require daily remembering. Thus, the failure rates of these methods may differ between populations. For example, clinical trials often report lower failure rates than rates observed in observational studies or practice. In addition, geographical differences in effectiveness have been presented (Mansour et al., 2010). For example, in an observational study on more than 50,000 women and 100,000 woman-years of combined oral contraceptive use, the failure rate was 1.9/100 woman years in the USA but only 0.5/100 in Europe (Barnett et al., 2017). In contrast to short-acting methods, the long-acting reversible contraception (LARC) methods do not require any tasks from the user, any daily remembering, or knowledge or skills for correct use, and are thus as effective in typical as in perfect use. Table 3 presents the rates of unintended pregnancy with different contraceptive methods in both perfect and typical use, with typical use estimates from two different studies. Mansour et al. conducted a systematic review of 139 studies, of which 64 were randomized clinical trials (Mansour et al., 2010). These typical use rates are closer to the perfect use rates than the typical use rates reported by Trussel and Aiken, where for most methods, data on typical use are from surveys in the USA (Trussell and Aiken, 2018). Notably, there is considerably less variation in reported failure rates for LARC methods compared to the other reversible methods.
### Table 3. Rates of unintended pregnancy per 100 women-years in perfect use and in typical use.

<table>
<thead>
<tr>
<th>Contraceptive method</th>
<th>Perfect use&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Typical use&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mansour et al. 2010&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Trussell and Aiken 2018&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>No method</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Permanent methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vasectomy</td>
<td>0.1</td>
<td>NA</td>
</tr>
<tr>
<td>Female sterilization</td>
<td>0.5</td>
<td>NA</td>
</tr>
<tr>
<td>Long-acting reversible methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contraceptive implant&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.1</td>
<td>0–0.03</td>
</tr>
<tr>
<td>Levonorgestrel-releasing intrauterine system</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Copper intrauterine device</td>
<td>0.6</td>
<td>0.2–1.3</td>
</tr>
<tr>
<td>Short-acting reversible methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined oral contraceptive pill</td>
<td>0.3</td>
<td>0–2.2</td>
</tr>
<tr>
<td>Progesterone only pill</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Contraceptive patch</td>
<td>0.3</td>
<td>0.7–1.2</td>
</tr>
<tr>
<td>Vaginal ring</td>
<td>0.3</td>
<td>0.3–1.2</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Condom</td>
<td>2</td>
<td>2.5–5.1</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>4</td>
<td>NA</td>
</tr>
</tbody>
</table>

<sup>a</sup>Consistent and correct use for one year  
<sup>b</sup>As commonly used, i.e. including not using the condom at every intercourse, forgetting pills, etc.  
<sup>c</sup>Levonorgestrel and etonogestrel implants  


### 2.3 LONG-ACTING REVERSIBLE CONTRACEPTION

The first long-acting reversible contraception (LARC) methods were different kinds of intrauterine contraceptives. The first plastic models were introduced in the 1960s, while in the 1970s, the first T-shaped copper-bearing intrauterine device was introduced. The levonorgestrel-releasing intrauterine system was developed in Helsinki, Finland, and reached the markets in the 1990s. The other LARC methods, i.e. the progesterone-only injectables and implants, were introduced in the same time period, with injectables introduced in the 1970s and the first subdermal contraceptive implant in the 1980s.
2.3.1 DEFINITION AND MECHANISM OF ACTION

Long-acting reversible contraception is defined by the National Institute for Health and Clinical Excellence in the UK as methods that require any kind of administration less than once a month (National Institute for Health and Clinical Excellence, 2005). According to this definition, LARCs comprise copper-bearing intrauterine devices (Cu-IUDs), levonorgestrel-releasing intrauterine systems (LNG-IUSs), levonorgestrel (LNG) and etonogestrel (ENG) contraceptive implants and depot medroxyprogesterone acetate (DMPA) injection. Intrauterine contraception (IUC) includes both copper-bearing devices and LNG-releasing systems and are small devices with plastic frames or threads that are inserted into the uterine cavity through the cervix. Contraceptive implants are thin rods the size of a matchstick, inserted subdermally under local anesthetic. The DMPA injection is an intermuscular injection repeated every three months. Figure 2 illustrates the three most commonly used LARC methods in Finland. The mechanisms of action of LARC methods available in Finland are summarized in Table 4.

Figure 2. Schematic illustrations of the three most commonly used long-acting reversible contraception methods in Finland, and their typical dimensions.
A. T-shaped copper intrauterine device
B. Levonorgestrel-releasing intrauterine system
C. Etonogestrel contraceptive implant
Table 4. The mechanism of action of LARC methods available in Finland, and maximal length of use according to Finnish national guidelines.

<table>
<thead>
<tr>
<th>Method</th>
<th>Length of use (years)</th>
<th>Primary mechanism of action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copper IUDs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥380 mm²</td>
<td>10</td>
<td>Prevents fertilization by affecting gamete viability and sperm motility (Alvarez et al., 1988, Gemzell-Danielsson et al., 2013, Stanford and Mikolajczyk, 2002).</td>
</tr>
<tr>
<td>&lt;300 mm²</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>LNG-IUSs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52 mg</td>
<td>7</td>
<td>Prevents fertilization by thickening of cervical mucus and inhibiting sperm migration (Jones and Critchley, 2000, Pakarinen et al., 1998, Stanford and Mikolajczyk, 2002).</td>
</tr>
<tr>
<td>19.5 mg</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>13.5 mg</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Implants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG</td>
<td>3</td>
<td>Thickening of cervical mucus and structural changes in the endometrium prevents fertilization. The ENG implant additionally prevents ovulation (Croxatto, 2002, Makarainen et al., 1998, Van den Bosch et al., 2002).</td>
</tr>
<tr>
<td>LNG (2-rod)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Injectable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMPA</td>
<td>(^b) (repeated injection every 3 months)</td>
<td>Prevents ovulation and thickens cervical mucus (Bathena, 2001).</td>
</tr>
</tbody>
</table>

Note: References found at end of the thesis. Abbreviations: IUD: intrauterine device, LNG-IUS: levonorgestrel-releasing intrauterine system, ENG: etonogestrel, LNG: levonorgestrel, DMPA: depot medroxyprogesterone acetate. \(^a\) Number indicates the surface area of copper. \(^b\) Maximal length of use not defined in the national guidelines on contraception. According to both the summary of product characteristics and the NICE guidelines on contraception, use beyond 2 years needs to be clinically reviewed (National Institute for Health and Clinical Excellence, 2005).

2.3.2 EFFICACY AND EFFECTIVENESS OF LARC METHODS

The efficacy of LARC methods is well documented. Real-world studies have identified pregnancy rates similar to those in clinical trials, reflecting the similarity in efficacy and effectiveness of these methods. In a study with over 17,000 LNG-IUS users in Finland, the pregnancy rate was 0.1 per 100 women during the first year of use (Backman et al., 2004). In the European Active Surveillance Study for intrauterine devices, over 58,000 women using either the LNG-IUS or the Cu-IUD were followed for one year. The pregnancy rate during the first year of use was 0.06 per 100 women for the LNG-IUS and 0.52 for the Cu-IUD (Heinemann et al., 2015). In a high-risk study population in the USA, the cumulative pregnancy rate per 100 women was 0.3% among IUC and implant users and 0.1% among DMPA injectable users at one year of use (Winner et al., 2012). Frequently cited clinical trials on the efficacy of LARC methods are presented in Table 5.
Table 5. Clinical trials on the efficacy of LARC methods.

<table>
<thead>
<tr>
<th>Study description</th>
<th>Country</th>
<th>Efficacy outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intrauterine contraception</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five years' experience with levonorgestrel-releasing IUDs. (Luukkainen et al., 1986)</td>
<td>Brazil and Finland</td>
<td>Randomized clinical trial on two LNG-IUSs (releasing 20 or 30 mcg LNG) and 380 mm² Cu-IUD NovaT.</td>
</tr>
<tr>
<td>Long-term contraception with the Levonorgestrel 20 mcg/day (LNG 20) and the Copper T 380Ag intrauterine devices: A five-year randomized study. (Sivin et al., 1990)</td>
<td>Brazil, Chile, Dominican Republic, Egypt, Singapore, USA</td>
<td>Randomized clinical trial on the LNG-IUS and T380 Cu-IUD, among 2,254 users and 6,000 woman-years.</td>
</tr>
<tr>
<td>Levonorgestrel-releasing and copper-releasing (Nova T) IUDs during five years of use: a randomized comparative trial. (Andersson et al., 1994)</td>
<td>Denmark, Finland, Hungary, Norway, Sweden</td>
<td>Randomized multi-center trial on 2,758 women using either 20 mcg/24 h LNG-IUS or 380 mm² Cu-IUD.</td>
</tr>
<tr>
<td><strong>Implants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical performance of a new two-rod levonorgestrel contraceptive implant: a three-year randomized study with Norplant implants as controls. (Sivin et al., 1997)</td>
<td>Chile, Egypt, Finland, Hong Kong, Singapore, Thailand, USA</td>
<td>Randomized multi-center trial comparing efficacy of 2-rod and 6-rod LNG implants among 1,198 women with a three-year follow-up.</td>
</tr>
<tr>
<td>A multicentre efficacy and safety study of the single contraceptive implant Implanon®. (Croxatto et al., 1999)</td>
<td>Chile, a Hungary, Netherlands</td>
<td>Open multi-center study on 635 women assessing the efficacy of a single-rod ENG implant.</td>
</tr>
<tr>
<td><strong>Injectables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multinational comparative clinical trial of long-acting injectable contraceptives: norethisterone enanthate given in two dosage regimens and depot-medroxyprogesterone acetate. Final report. (World Health Organization Task Force, 1983)</td>
<td>Brazil, Chile, Egypt, Italy, Luxembourg, Mexico, Netherlands, Nigeria, Pakistan, Philippines, Thailand, Yugoslavia, Zambia</td>
<td>Randomized multi-center trial on 1,587 women on either DMPA with 60 days' interval and NET-EN with either 60- or 60+84-day interval.</td>
</tr>
</tbody>
</table>

2.3.3 ACCEPTABILITY AND SIDE-EFFECTS OF LARC METHODS

Today, LARC methods are generally well tolerated with high rates of continuation and satisfaction (Short et al., 2012). Continuation rates of IUCs and implants have reportedly exceeded those of DMPA and short-acting methods. In the CHOICE project, a large cohort study providing contraception free of charge in Missouri, USA, three-year continuation rates reached 70% for hormonal and copper IUCs and 56% for implants (Diedrich et al., 2015). The corresponding figure for DMPA was 33%, while 32% continued oral contraceptives for three years.

However, the early LARC methods were accompanied by side-effects and even non-acceptable adverse events. The first intrauterine contraception models caused bleeding problems and had high rates of both expulsion and pregnancy. More alarmingly, serious infections and deaths as well as infertility were linked to some models in the 1970s (Boonstra et al., 2000, Cramer et al., 1985, Daling et al., 1985). The first versions of the contraceptive implant also presented frequent – although not as severe – side effects. In addition to the common side-effects of bleeding disturbances, weight gain and headache, acceptability was low due to problems with removal of the six-rod system, and in the USA, multiple lawsuits led to the method being removed from the market (Boonstra et al., 2000, Harrison and Rosenfield, 1998). The use of the DMPA injectable has been restricted due to a possible association with reduced bone density (Lopez et al., 2015).

With the IUC methods available today, side-effects are still prevalent, although rarely severe. A vast body of evidence assures that the risk of PID among IUC users is not elevated after the first days after insertion and that IUC use does not cause infertility (Farley et al., 1992, Grimes, 2000, Hubacher et al., 2001). In a recent study, the risk of a PID during IUC use was also below 1% among women at high risk of sexually transmitted infections (STI) (Birgisson et al., 2015).

According to Finnish official product data sheets for the 52-mg LNG-IUS, 380-mm² Cu-IUD, ENG implant, and the DMPA injectable, all of these LARC methods commonly cause changes in the menstrual bleeding pattern, with at least one out of ten users reporting this side-effect. Also, nausea or abdominal pain and dysmenorrhea has been reported for all the abovementioned methods. For all except the Cu-IUD, side-effects such as mood changes, headache, acne, breast tenderness and weight changes have been described.

2.3.4 RECOMMENDATIONS AND GUIDELINES ON LARC USE

Through the second part of the 20th century, intrauterine contraception (IUC) was considered a method mainly for parous women. On the contrary, the contraceptive implant was recommended for adolescents from the beginning (Boonstra et al., 2000). With the rapidly growing body of evidence on the safety of the current IUC methods, guidelines and recommendations on IUC started to change. Already in 2000, the WHO MEC classified the use of copper IUDs...
and LNG-IUSs as category 2 (i.e. Generally use the method, Table 2) for both nulliparous women and women under the age of 20. This grading remains in the WHO MEC 2015, declaring that the risk of pregnancy, perforation, expulsion and infection is low, regardless of age, and that differences according to parity may not be of clinical relevance, but that expulsion may be more prevalent among young women (World Health Organization, 2000, 2015). In the USA, being nulliparous was deleted as a contraindication of the T380 Cu-IUD in 2005, but the 52-mg LNG-IUS product data sheet dated 2008 still states “Mirena (52-mg LNG-IUS) is recommended for women who have had at least one child” (Bednarek and Jensen, 2009).

Today, several family planning organizations recommend LARC methods as first-line contraceptives for both adults and adolescents. The Finnish national guidelines on contraception affirm that LARC methods – including intrauterine contraception – can be used by women of all ages (Current Care Guidelines, 2015). All women seeking contraception should be informed about LARC methods, their safety and efficacy, according to the UK National Institute for Health and Clinical Excellence (NICE) guidelines on LARC use (National Institute for Health and Clinical Excellence, 2005). The Faculty of Sexual and Reproductive Healthcare underlines in their clinical guidance on intrauterine contraception that use of IUCs should not be dependent on parity or age (Faculty of Sexual & Reproductive Healthcare of the Royal College of Obstetricians & Gynecologists, 2015).

In the USA, both gynecologist and pediatrics organizations declare that LARC methods serve as a first-line choice of birth control for both adolescent and adult women (American Academy of Pediatrics, 2014, American College of Obstetricians and Gynecologists, 2015). Clinicians and researchers have also long advocated the use of these methods as a means to reduce rates of unintended pregnancy (Blumenthal et al., 2011, Hathaway et al., 2014, Parks and Peipert, 2016, Speidel et al., 2008).

In addition, the most recent WHO MEC updated the recommendation on LARC use in the post-partum period: contraceptive implants are in category 2 immediately post-partum, including for breastfeeding women (previously category 3), and the LNG-IUS within 48 hours post-partum is in category 1 for non-breastfeeding and category 2 for breast-feeding women. LARC methods are also recommended for post-abortion and post-partum contraception by expert organizations in the USA and UK (American College of Obstetricians and Gynecologists, 2016, Faculty of Sexual & Reproductive Healthcare of the Royal College of Obstetricians & Gynecologists, 2017).

2.3.5 BARRIERS TO LARC USE

Individual reasons not to use LARC methods include the abovementioned side-effects, but also reasons that could be addressed by comprehensive and women-centered counseling. These include not wanting a foreign body inside, not being able to control the method, and not being in a relationship (Black et
...Hall et al., 2012, Coles and Shubkin, 2018, Hall et al., 2016). In a survey among 194 young women in the UK, fear of pain and needles was the most important reason for non-interest in LARC methods (Bharadwaj et al., 2012). However, despite updated eligibility criteria and clinical guidelines, many system and provider barriers also exist, especially for IUCs.

**Risk of infections:** Early IUC models were linked to severe infections and infertility, which made both contraception providers and women concerned about the safety of these methods (Black et al., 2012, Shoupe, 2016). Despite thorough research supporting the safety of current IUC models (section 2.3.3), concern about PID is still a barrier to recommending IUC, according to a survey study among health care providers in eight European countries and Canada (Buhling et al., 2014a). The same has been noted in the USA, where one-fourth of family physicians and gynecologist have reported concern about the link between IUCs and infertility as a barrier to IUC prescription (Harper et al., 2012).

**Nulliparity:** Women of young age and nulliparous women were for long considered non-eligible for IUC contraception, largely due to the perceived risk of PID and infertility. In addition, there has also been concerned that insertion of IUCs would be more difficult or painful among young and nulliparous women (Black et al., 2012). However, there is vast evidence of the safety of IUC methods among young and nulliparous women (American Academy of Pediatrics, 2014, Kaislasuo, 2015, National Institute for Health and Clinical Excellence, 2005). In a Finnish clinical trial on LNG-IUS use among young nulliparous women, 85% of insertions reported as easy by the performing doctors (Suhonen et al., 2004). In two trials on the 13.5 mg and 19.5 mg LNG-IUSs with narrower insertion tubes, up to 94% of insertions were reported as easy, and the majority of adolescent participants reported none or mild insertion pain (Gemzell-Danielsson et al., 2016, Gemzell-Danielsson et al., 2012). Nevertheless, in the abovementioned survey study in Europe and Canada, nulliparity was reported as one of the most frequent barriers to IUC use (Buhling et al., 2014a).

**Unavailability of same-day insertions:** Same-day insertions have been shown to increase the likelihood of LARC initiation, as compared to two-visit protocols allowing, for instance, for STI and pregnancy screening (Bergin et al., 2012). However, neither routine screening of STIs among women at low risk or screening for cervical cancer is required prior to LARC initiation, and initiation is possible at any time of the menstrual cycle, given that the health provider can reasonably assume the woman is not pregnant (Current Care Guidelines, 2015, Faculty of Sexual & Reproductive Healthcare of the Royal College of Obstetricians & Gynaecologists, 2015). High costs of stocking of methods can also reduce the possibility of same-day insertions, e.g. in the USA with predominantly private health care providers (Beeson et al., 2014).

**Cost:** Compared to short-acting methods, LARC methods have high up-front costs if no reimbursement or insurance coverage is available. In Finland, contraceptive methods are not universally reimbursed, but some municipalities
offer contraception free of charge. LARC methods have markedly higher up-front costs than short-acting methods: e.g. €152 for an LNG-IUS compared to €6–14/month for oral contraceptives. In Sweden, reimbursement varies between counties (Sydsjo et al., 2014). In the UK, the NHS provides both contraceptive services and methods free of charge, while in the US, initiation of a LARC method can result in a bill of up to $1,300 for women without insurance. Therefore, price is considered a major barrier to initiating a LARC method in many countries (Buhling et al., 2014a, Eisenberg et al., 2013, Kumar and Brown, 2016).

2.3.6 PREVALENCE OF LARC USE

Despite the high continuation rates and superior efficacy of LARC methods, these methods are used less than short-acting methods in many developed countries (Kavanaugh and Jerman, 2018, Lindh et al., 2017, United Nations, 2019b). There is also great variability in the prevalence of use between continents (Buhling et al., 2014b). In Europe, 18% of women in a survey study reported current use of LARC methods, while 55% reported current use of short-acting methods, including injectables (Merki-Feld et al., 2018). In a survey study among women in five European countries conducted in 2011, the highest current use of IUC was in Sweden (19%) and the lowest in Romania (3.5%). In the same study, DMPA injectables were not commonly used in any of the surveyed countries, with current use ranging from 0% (France) to 5.4% (UK), and contraceptive implants were used even less (de Irala et al., 2011).

Estimates from a Nordic study on contraceptive use based on prescriptions and manufacturer’s sales figures are more conservative, reporting a prevalence of LARC use of 20% among women aged 15–49 years in Sweden and 18% in Finland in 2013 (Lindh et al., 2017). In a recent survey study from Sweden, 31% of women reported current LARC use (Hellstrom et al., 2019).

Recently, the use of LARC methods has also been on the rise in the USA, where the prevalence for a long time was lower than in Europe (Eeckhaut et al., 2014). In the early 2000s, only around 1.5% reported LARC use, while over 10% did so in the 2010s (Branum and Jones, 2015, Daniels et al., 2015, Kavanaugh and Jerman, 2018).

An increase in the use of LARC methods among adolescents has also been noticed in the Nordic countries, with an increase from 7% to 17% among 15- to 19-year-olds in Sweden between the years 2008 and 2015 (Hognert et al., 2018). In the USA, only 6% of nulliparous women used a LARC method in 2015 (Ihongbe and Masho, 2018). However, data on LARC use among adolescents are incomplete in many countries and e.g. the UN registers contraceptive use only among married women and women living in union (Apter, 2019). Figure 3 shows the proportion of women using LARC methods according to survey-based estimates from the recent UN report on global contraceptive use (United Nations, 2019b).
Figure 3. Proportion of women (married or living in union) using LARC methods. Data from the UN World Contraception Use 2019 Report (United Nations, 2019b). Note: Injectables not included. Only surveys conducted in the 2000s are included, with the most recent estimate per country displayed. For the following countries, only IUD use is displayed, as data on contraceptive implant use was missing: Armenia, Azerbaijan, Belarus, Belgium, Bulgaria, Ethiopia, Honduras, Finland, Gabon, Georgia, Greece, Guinea, Hungary, India, Iraq, Ireland, Italy, Lao PDR, Lebanon, Libya, Moldova, Morocco, Netherlands, Papua New Guinea, Portugal, Romania, Russia, South Korea, Somalia, Switzerland, Syria, Uganda, and Venezuela.
2.3.7 CHARACTERISTICS OF LARC USERS
Several characteristics have been found to associate with a woman’s interest in LARC methods. According to the UN report on global contraceptive use, married women more often rely on permanent or long-acting methods, while unmarried women more often report male condom or contraceptive pill as their method of choice (United Nations, 2019a). The same distribution is seen for age, with long-acting and permanent methods dominating in the older age groups. However, associations vary between studies, reflecting differences in the study populations. In addition, characteristics vary according to the specific LARC methods (Daniels et al., 2015, Eeckhaut et al., 2014).

In Europe, LARC use increases as a function of age. In a study from five countries with over 12,000 participants, LARC use was most common among women aged 35–44 years. In a comparison of national surveys from nine low-fertility countries, LARC use increased after the age of 30 in all assessed European countries (Eeckhaut et al., 2014, Skouby, 2010). On the contrary, the highest point prevalence for LARC use was reported among women aged 18–24 years in the USA and 25–29 years in Australia (Eeckhaut et al., 2014). A nationally representative survey sample in Australia, however, showed no association between age and current use of LARC methods (Coombe et al., 2017). Among LARC users, IUC users are older than implant and injectable users (Cea-Soriano et al., 2014, Haimovich, 2009). In a study on 311 women in four European countries switching from a short-acting method to either an LNG-IUS or an ENG implant, women choosing the LNG-IUS were slightly older (30 vs. 27 years) (Short et al., 2012).

Parous women use LARC methods more often than do nulliparous women (Coombe et al., 2017, Eeckhaut et al., 2014). Specifically, the use of IUCs is associated with parity, while use of contraceptive implants has been shown to be equally common among parous and nulliparous women (Haimovich, 2009, Kavanaugh and Jerman, 2018, Short et al., 2012). However, no association between a history of abortion and LARC use was found in the Australian survey data (Coombe et al., 2017). Among 800 women in the immediate post-partum period, the only characteristics associated with the intent to initiate a LARC method were not trying to conceive and no desire for pregnancy (Tang et al., 2013). Also, previous unintended pregnancy did not increase the odds of LARC use in a US survey study (Kavanaugh et al., 2015).

No general association between LARC use and educational level has been confirmed, as studies have presented contrasting results (Coombe et al., 2017, Daniels et al., 2015, Eeckhaut et al., 2014). In the Australian study, women who were unemployed or not working had an increased likelihood of LARC initiation compared to working women (Coombe et al., 2017).
2.4 SERVICE DELIVERY SYSTEMS

The importance of reproductive health services, including family planning, was internationally recognized at the International Conference on Population and Development in Cairo in 1994. The program of action was initially adopted by 179 governments and was an important base for the UN Millennial goals agreed upon in 2000 (United Nations, 2014).

In 2004, WHO released its first global strategy on reproductive health. The report is guided by basic human rights and gender equality, and proposes every country to establish a national reproductive health program (World Health Organization, 2004). The quality and accessibility of services affect contraception use, and are thus an important focus in evaluating and improving contraceptive services (Eshre Capri Workshop Group, 2018). Accordingly, in order to implement programs and recommendations on contraceptive use in national settings, family planning services and active implementation strategies are needed (Chen et al., 2017, Wang et al., 2016).

2.4.1 FAMILY PLANNING SERVICES IN SELECTED DEVELOPED COUNTRIES

In Europe, family planning services are evaluated in a project organized by the European Parliamentary Forum for Sexual and Reproductive Rights. The level of access to modern contraception is ranked based on policies regarding reimbursement, the accessibility and quality of family planning services, and availability of online information on contraception. In the results presented in the Contraceptive Atlas, Belgium, France and the UK hold the top three positions, while Finland has moved up in the ranking from position 26 in 2018 to 16 in 2019, as over 40 municipalities decided to reimburse contraception for young women (European Parliamentary Forum for Sexual and Reproductive Rights, 2019). Figure 4 presents the results from the most recent European ranking on access to modern contraception.

All Nordic countries provide public health care services gratis or at nominal prices, including visits at family planning clinics. However, only Sweden has a national reimbursement program for contraception (European Parliamentary Forum for Sexual and Reproductive Rights, 2019). In the UK, the NHS provides both contraceptive services and methods free of charge.

In the USA, health care services are predominantly private and patient costs depend on the insurance status of the patient. The implementation of the Affordable Care Act (ACA) reduced or even removed out-of-pocket costs for all Food and Drug Administration approved contraceptive methods for a large proportion of American women, although exceptions exist (Seiler et al., 2014, Weisman and Chuang, 2014).
Figure 4. European countries ranked by access to modern contraception, evaluated by policies on access to contraception and family planning services, and availability of online information (European Parliamentary Forum for Sexual and Reproductive Rights, 2019).

2.4.2 THE FINNISH HEALTH CARE SYSTEM

The municipalities in Finland have substantial self-government and are, according to the Primary Health Care Act 1972, responsible for producing health care services for the residents (Finlex, 1972). Primary health care services are provided at health centers administered by the municipalities, although sometimes operated by private providers (Ministry of Social affairs and Health, 2020). In addition to the management of acute and chronic illness, primary health care includes maternity and child clinics, contraceptive services, rehabilitation, dental services, and occupational health for students. Health services can vary between municipalities, as some offer a more comprehensive selection of services than the required minimum. The municipalities are also responsible for arranging specialized care, which is currently organized by 20 hospital districts. The hospitals are owned and run by the authorities in the districts.

Public health care services are available at nominal fees in both primary and specialized units. The maximum patient fees are specified in the Act on Social and Health Care Client Fees (Finlex, 1992). The maximum fee for a health center visit is set at €20.60 and for a hospital out-patient visit €41.20. Municipalities can choose to collect lower fees or provide services free of
charge. There are no extra fees for various procedures, X-rays, laboratory exams, or in-ward medication.

Although the public health care services are provided universally to all residents of Finland, there is also a network of private health care producers. Occupational health is predominantly provided by private sources, and the proportion of residents with private insurance is increasing.

2.4.2.1 Contraceptive services

Contraceptive and maternal health services are guaranteed by law and are to be offered free of charge for all residents (Finlex, 1972). With the Primary Health Care Act, the importance of family planning services was recognized. These services are implemented as a part of the primary health care system, with general practitioners and public health nurses in the front line. From the 1970s, the provision of the services was guided through an advisory from the health authorities (Rimpela et al., 1996).

As stated above, the municipality is responsible for arranging contraceptive services. These services can be provided at health centers, in maternity or child health clinics, or in family planning clinics (Sannisto and Kosunen, 2010). In 2008, 25% of municipalities in Finland arranged the services in specific family planning clinics, 68% in conjunction with maternity, child health, or other clinics, and only 6% as regular health center visits (Kosunen, 2009).

The contraceptive services typically include counselling on sexuality and contraceptive methods, LARC insertions and removals, and laboratory tests if needed. The contraceptive methods are not universally reimbursed by the mandatory health insurance in Finland. Nevertheless, some municipalities provide contraceptives free of charge to the residents, usually to a specific age group or clinical population. Most commonly, municipalities provide 3–6 months of oral contraception after childbirth. This was already recommended in the 1970s in the advisory on family planning services (Rimpela et al., 1996). Today, the Finnish National Action Plan for Sexual and Reproductive Health recommends that municipalities provide women under the age of 20 the contraceptive method of her choice free of charge (Klemetti and Raussi-Lehto, 2013). Some municipalities have decided to take up this recommendation, and provide contraception free of charge to women up to the age of 20 or 25 years. In 2013, only a few municipalities provided LARC methods free of charge in the Helsinki Metropolitan Area, but there are no nationwide data on reimbursement regimes in different municipalities in Finland.

2.4.2.2 Finnish legislation on induced abortion

Induced abortion can be requested on several grounds in Finland (Finlex, 1970). Even though the request is to be endorsed by two doctors, the law is interpreted liberally, and induced abortion is practically always provided when
the gestational age does not exceed 20 weeks. The most common ground on which induced abortion is requested is the social indication, i.e. if delivery or childcare would constitute an unbearable burden, and it accounts for 92% of all induced abortions in Finland (Heino and Gissler, 2017). After an induced abortion, it is recommended by the National Guidelines on Induced Abortion (Current Care Guidelines, 2013) to attend a follow-up visit, but there is no economic benefit tied to this visit.

2.5 PROMOTING THE USE OF LONG-ACTING REVERSIBLE CONTRACEPTION

As evidence of the superior effectiveness of LARC methods compared to other reversible contraceptive methods is solid, expert organizations advocate LARC use as a means to reduce the rates of unintended pregnancy and induced abortions (American College of Obstetricians and Gynecologists, 2015, Eshre Capri Workshop Group, 2018, National Institute for Health and Clinical Excellence, 2005).

Promoting LARC methods requires addressing the persistent barriers to their use. One LARC-promoting target could thus be to improve the accessibility of same-day insertions, as same-day insertions have been shown to increase LARC initiations (Bergin et al., 2012). Another target could be immediate or rapid access to post-abortion LARC, which is safe, increases the uptake of LARC methods, and reduces the need for subsequent abortion (Korjamo et al., 2017, Pohjoranta et al., 2015). Increased awareness of LARC methods among pregnant women could increase post-partum use and lower the risk of rapid repeat pregnancy (Faculty of Sexual & Reproductive Healthcare of the Royal College of Obstetricians & Gynecologists, 2017, World Health Organization, 2015).

Programs focusing on the knowledge and skills of health care providers as well as on patient awareness have reportedly increased LARC use. A cluster randomized trial in the USA examined the effect of educating clinical staff in LARC counseling and insertion techniques. LARC initiation was significantly higher at intervention sites compared to control sites (28% vs. 17%). The pregnancy rate was almost cut in half among women attending family planning visits, but there was no difference in pregnancy rates among women at visits regarding induced abortion (Harper et al., 2015). Likewise, in an Australian randomized clinical trial on a comprehensive intervention, educating family physicians and providing rapid LARC insertions, LARC use at 12 months was 48% at intervention sites and 33% at control sites, a statistically significant difference (Mazza et al., 2019). In the CHOICE project, all participants received brief written information on LARC methods. In addition, participants enrolled at university clinic sites (75% of all participants) were counselled on all contraceptive methods according to a structured counselling protocol. Participants enrolled at other sites were counselled by each clinic’s normal
counselling routine. Interestingly, there was no difference in LARC initiation rates at sites providing structured counselling compared to sites providing normal counselling (Madden et al., 2013).

As cost is one of the major barriers to LARC use, programs providing LARC methods free of charge have also been advocated (Cleland et al., 2011, Fox and Barfield, 2016).

2.5.1 FREE-OF-CHARGE LARC PROGRAMS

2.5.1.1 Characteristics of free-of-charge LARC users
The characteristics of LARC users have been described in section 2.3.6. However, some characteristics show different associations or are more pronounced regarding the use of LARC methods when these are provided free of charge.

Among 1,700 low-income women in the USA, all eligible for free-of-charge contraception immediately post-partum, LARC initiation was more common among women under the age of 25 years as compared to older women (Fang et al., 2018). This is in line with the overall LARC use in the USA, where the highest prevalence has been reported among women aged 18–24 (Eeckhaut et al., 2014). On the contrary, in the UK, where all contraceptive methods are free on the NHS, LARC use is most common among women over 34 years of age. However, IUC use constitutes the main part of LARC use in the UK, and implants and injectables are more common among younger women (Cea Soriano et al., 2014).

While no association between age and LARC initiation was found in multivariate analysis of 800 privately insured women in Pennsylvania, USA (Nelson et al., 2019), a young age was negatively associated with initiating a LARC method compared to women over the age of 25 years in the CHOICE project in St Louis, Missouri, USA (Secura et al., 2010). The CHOICE project enrolled 9,256 women to receive the contraceptive method of their choice free of charge. Recruitment targeted young women, women of color, and women with a history of abortion or unintended pregnancy. In addition to free-of-charge provision of contraceptives, the project removed multiple barriers to LARC use by providing structured counseling on LARC methods and health care personnel training.

A history of induced abortion increased the odds of choosing a LARC method when all methods were provided free of charge both in the CHOICE population and among the privately insured women in Pennsylvania (Nelson et al., 2019, Secura et al., 2010). In a separate analysis of adolescent participants of the CHOICE project, prior induced abortion was not associated with LARC initiation in univariate analysis, while previous unintended pregnancy showed a significant association (Mestad et al., 2011). On the contrary, a history of an induced abortion prior to the present abortion
decreased the odds of initiating a free-of-charge LARC method among women assessed post-abortion (Fang et al., 2018). Parity was assessed as a continuous variable in the CHOICE study, showing a positive association with LARC use (Secura et al., 2010). Among post-abortion women, being nulliparous did not decrease the odds of choosing a LARC (Fang et al., 2018). Parity was not assessed in the Pennsylvania study. However, the number of children in the household was not associated with LARC initiation (Nelson et al., 2019).

In a survey among 2,500 CHOICE participants, 60% of women initiating a LARC method reported a low socioeconomic status, and adolescent CHOICE participants receiving government support were more likely choose a LARC method over a non-LARC method (Madden et al., 2015, Mestad et al., 2011).

Table 6 summarizes the main findings from three studies on the characteristics of LARC users in the USA, in settings where all contraceptive methods were provided free of charge. Interestingly, these results show that findings regarding characteristics associated with free-of-charge LARC initiation are inconsistent, even within the same country. This highlights the importance of studies in different clinical settings to more precisely identify the range of factors correlated with choosing a LARC method.

Table 6. Main findings from three studies on characteristics associated with use of free-of-charge LARC in the USA: † indicates a positive association, ‡ indicates a negative association, and ‡ indicates no significant difference. Only adjusted results are displayed. Characteristics not studied are denoted by –.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Nelson et al. 2019</th>
<th>Fang et al. 2018</th>
<th>Secura et al. 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young age</td>
<td>⇧</td>
<td>†</td>
<td>⇧</td>
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<tr>
<td>History of delivery or pregnancy</td>
<td>–</td>
<td>–</td>
<td>‡</td>
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<tr>
<td>History of abortion or unintended pregnancy</td>
<td>†</td>
<td>‡</td>
<td>‡</td>
</tr>
<tr>
<td>Married or cohabiting</td>
<td>⇧</td>
<td>–</td>
<td>‡</td>
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</table>

References: (Fang et al., 2018, Nelson et al., 2019, Secura et al., 2010)

2.5.1.2 Associations between free-of-charge programs, LARC uptake, and induced abortions

The association between the availability of contraceptive methods free of charge and increased uptake of LARC is well established in selected study samples and well-defined programs. In some study settings where LARC initiations have increased after free-of-charge provision of these methods, rates of births and abortions have decreased. However, evidence is limited on the association between public free-of-charge programs, LARC initiations, and rates of induced abortions.

According to a theoretical model evaluating costs for the NHS in the UK, LARC methods are more cost-effective than other methods in preventing
unintended pregnancies (Mavranezouli and Larc Guideline Development Group, 2008). A theoretical evaluation in Norway identified that a hypothetical increase in LARC would be cost-saving, when accounting for direct and indirect costs attributable to increased LARC use as well as to unintended pregnancy and induced abortion (Henry et al., 2015).

A large study among privately insured women across the United States reported that LARC increased with 3% after the implementation of the ACA (Snyder et al., 2018). On the contrary, no effect of LARC uptake was seen during the first year following ACA implementation (Pace et al., 2016). A comparison of two cross-sectional cohorts before and after ACA implementation did not detect any change in LARC use among sexually active women (Bearak and Jones, 2017).

LARC use increased from 1% to 15% in Iowa when public funding for contraceptive services increased through both insurance extensions and a private initiative. Concomitantly, there was a reduction in abortion rates, described as a 4% reduction in abortions for one new LARC per 100 women (Biggs et al., 2015). An increase in LARC uptake of similar magnitude was seen in Colorado after an initiative increasing eligibility for coverage for contraceptive methods. LARC use rose from 5% to 19% among 18- to 24-year-old women during the study period (Ricketts et al., 2014).

A sub-analysis of a cluster randomized trial initially assessing the effect of staff training on LARC uptake evaluated whether LARC uptake was different at sites providing insurance expansions for contraception. Women with public insurance initiated LARC methods two times more often than did uninsured women (Thompson et al., 2016).

Participants in the CHOICE project were provided their contraceptive method of choice at no cost. Altogether, 75% of enrolled women chose a LARC method, as compared to an estimated 5% of women using LARC methods at other clinics in the region (McNicholas et al., 2014, Peipert et al., 2012). The rate of induced abortions in this selected study population was 4.4/1000 participants during the first year of follow-up compared with markedly higher regional and national levels (17.7 and 19.6/1000, respectively) (Peipert et al., 2012).

Table 7 presents a summary of selected studies on programs where contraception has been provided free of charge, or with marked financial assistance. The focus lies on the rates of LARC initiations and induced abortions. All studies presented are from the USA, as no European studies with the abovementioned criteria were identified in the literature search. This is understandable, since many Western European countries have during a long period provided accessible and affordable contraceptive services (see section 2.4), while in the USA, the recent implementation of the ACA enabled studies on the association between free-of-charge programs, LARC uptake, and abortion rates with clear before and after definitions.
Table 7. Selected studies on free-of-charge programs since 2012, focusing on LARC method uptake and abortion rates, together with qualitatively synthesized methodological strengths and limitations.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Objective</th>
<th>LARC uptake</th>
<th>Abortion rates</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventing Unintended Pregnancies by Providing No-Cost Contraception</td>
<td>Prospective cohort study providing all contraceptive methods free of charge to 9,256 women aged 14-45 at-risk for pregnancy. 63% had a history of unintended pregnancy.</td>
<td>To promote use of LARC methods and to provide contraception methods free-of-charge to a large cohort.</td>
<td>75% of participants chose a LARC method.</td>
<td>Adjusted abortion rate in 2008: 4.4/1000 participants vs. 17.7/1000 (regional level) and 19.6/1000 (national level).</td>
<td>All methods available free-of-charge allowing to assess LARC acceptance when costs are removed.</td>
<td>No control group, i.e. no valid comparisons can be made.</td>
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<td>(Peipert et al., 2012)</td>
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<tr>
<td>Game Change in Colorado: Widespread Use of Long-Acting Reversible</td>
<td>Ecological study of a population-level intervention among women aged 15–24 years in Colorado during 2008–2011.</td>
<td>Assessing the effect of a program increasing access and funding to LARC methods in 2009 on LARC initiations and fertility rates.</td>
<td>LARC initiation increased from 5% to 19%.</td>
<td>Abortion rates declined from 10.9 to 7.2 / 1000 15–19-year-olds (compared to 14. to 10.2) and from 22.0 to 18.0 / 1000 20–24-year-olds (compared to 26.2 to 27.8)</td>
<td>The population-based setting allows for measuring outcomes on the population level.</td>
<td>Methods provided free-of-charge depend on poverty level and on client’s ability to pay, which make evaluation of isolated effect of the program difficult.</td>
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<tr>
<td>Contraceptives and Rapid Decline in Births Among Young, Low-Income</td>
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<tr>
<td>Women (Ricketts et al., 2014)</td>
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<tr>
<td>Did increasing use of highly effective contraception contribute to</td>
<td>Register-based study of 544,248 women living in Iowa in 2005–2012.</td>
<td>To assess LARC use and abortion rates in Iowa, when access to family planning and abortion services and funding for family planning services for low-income women increased.</td>
<td>LARC use increased from 1% in 2005 to 15% in 2012.</td>
<td>Abortion rates declined from 8.7/1000 women in 2005 to 6.7/1000 women in 2012.</td>
<td>Well defined setting with complete population and no change in abortion laws.</td>
<td>Use of non-comprehensive data, underestimating number of abortions and including data only on family planning clients at sites receiving specific funding.</td>
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<tr>
<td>births in Iowa? (Biggs et al., 2015)</td>
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<tr>
<td>Post-abortion Contraceptive Use and Continuation When Long-Acting</td>
<td>Prospective cohort study of 518 women post-abortion: 143 low-income women eligible to free-of-charge LARC, 112 non-eligible low-income women and 263 high-income non-eligible women.</td>
<td>To compare LARC acceptance and abortion rates among women seeking abortion care in Texas between 2014–2016, eligible or not eligible to free-of-charge LARCs.</td>
<td>65% of eligible women initiated a LARC method, compared to 5% of non-eligible low-income women and 24% of non-eligible high-income women.</td>
<td>Risk of pregnancy was higher among low-income non-eligible (HR 3.28, 95% CI 1.15–9.31) than low-income eligible women during one-year follow-up.</td>
<td>Pure post-abortion sample decreases the effect of confounding present at contraceptive counseling visits, e.g. predetermined desires of LARC methods.</td>
<td>Placing in study group depends on eligibility to LARC program, which alters the comparability of groups.</td>
</tr>
<tr>
<td>Reversible Contraception Is Free. (Goyal et al., 2017)</td>
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</tbody>
</table>

**Abbreviations:** LARC: Long-acting reversible contraception, OR: odds ratio, CI: confidence interval, aOR: adjusted odds ratio, HR: hazard ratio, aHR: adjusted hazard ratio. References found at end of document.
Table 7. (Continued from previous page) Selected studies on free-of-charge programs since 2012, focusing on LARC method uptake and abortion rates, together with qualitatively synthesized methodical strengths and limitations.

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<th>Abortion rates</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did Contraceptive Use Patterns Change after the Affordable Care Act? A Descriptive Analysis. (Bearak and Jones, 2017)</td>
<td>Descriptive analysis of two cross-sectional cohorts: 7,894 women aged 18–39, at risk of unintended pregnancy (surveys of 4,524 in 2012 and 3,370 in 2015)</td>
<td>To determine whether public funding through the Affordable Care Act increased contraception use.</td>
<td>No change in LARC use before and after implementation of the ACA. Contraceptive use among the non-sexually active increased by 37–44%.</td>
<td>Not assessed.</td>
<td>Detailed questions for assessing contraceptive use in relation to sexual activity.</td>
<td>Design does not permit the detection of change over time. Selection not designed for a nationally representative sample.</td>
</tr>
<tr>
<td>The Impact of the Affordable Care Act on Contraceptive Use and Costs among Privately Insured Women. (Snyder et al., 2018)</td>
<td>Retrospective cohort of privately insured women from all states in the USA (n &gt; 50 million).</td>
<td>To assess how costs for contraceptive methods changed after the implementation of the Affordable Care Act and whether it affected LARC uptake.</td>
<td>The implementation of the ACA was associated with increased LARC initiation (aOR 1.03, 95% CI 1.02–1.04)</td>
<td>Not assessed.</td>
<td>Data do not include information on Medicaid coverage or uninsured women.</td>
<td>Key demographic variables not available. Methodology does not account for the rise in LARC initiation starting long before the ACA implementation.</td>
</tr>
<tr>
<td>Contraceptive Method Use During the Community-Wide HER Salt Lake Contraceptive Initiative. (Sanders et al., 2018)</td>
<td>Prospective cohort study with a control group. 11,509 women aged 16–45 years receiving contraceptive services in 2015–2017 were followed.</td>
<td>To describe changes in contraceptive use when costs were removed for all contraceptive methods.</td>
<td>LARC initiation increased after the introduction of free-of-charge contraception: OR 1.6, 95% CI 1.5–1.6)</td>
<td>Not assessed.</td>
<td>Introduction of a new contraceptive program in the existing infrastructure of family planning services increases generalizability.</td>
<td>Selection bias at enrollment with large differences between participants in study groups, and methodological considerations of the time series analysis.</td>
</tr>
</tbody>
</table>

Abbreviations: LARC: Long-acting reversible contraception, OR: odds ratio, CI: confidence interval, aOR: adjusted odds ratio, HR: hazard ratio, aHR: adjusted hazard ratio. References provided at end of the thesis.
Aims of the study

3 AIMS OF THE STUDY

This doctoral study aimed to investigate the effects and characteristics of a program providing long-acting reversible contraceptive (LARC) methods free of charge in an unselected population. The public LARC program in the City of Vantaa, Finland, entitled women to their first LARC method without charge. The program was implemented in January 2013 and offered a valuable setting to study the effects of free-of-charge LARC provision in an unselected population.

This is the first study on the free-of-charge provision of LARC methods at the population level in Finland. In addition, studies on factors predicting the initiation of free-of-charge LARC methods have mostly been from the USA, and have yielded disparate results. Previous studies on free-of-charge contraception have displayed an association between the availability of free-of-charge LARC methods and an increased uptake of these methods, but information on the effect on the rate of induced abortions has been both limited and mixed.

The specific aims of this study were to:

1. Identify factors that predict the initiation of LARC methods when these are provided free of charge in public health care. (Study I)

2. Estimate the effect of free-of-charge LARC methods on the individual need for induced abortion. (Study II)

3. Investigate the impact of the public free-of-charge LARC program on method initiation rates in the City of Vantaa. (Study III)

4. Study the impact of the public free-of-charge LARC program on the rate of induced abortion in the City of Vantaa. (Study III)
4 MATERIALS AND METHODS

4.1 ETHICAL APPROVAL AND PERMISSIONS

The studies of this thesis were approved by the ethics committee of the Hospital District of Helsinki and Uusimaa. All register-keeping organizations of the registers used have also evaluated and approved the study: the City of Vantaa, National Institute for Health and Welfare, and Statistics Finland. There was no need for the informed consent of the study subjects in these register-based studies.

4.2 SETTING

The research comprising this dissertation is based on real-world data collected from the City of Vantaa in the Helsinki Metropolitan Area. In January 2013, a public program was launched, entitling all women in Vantaa to their first long-acting reversible contraceptive (LARC) method free of charge. The program originated as a tool to address the rate of induced abortions in Vantaa, which for long had been higher than in neighboring municipalities. The researchers had no role in the design or implementation of the program.

4.2.1 THE PUBLIC LARC PROGRAM IN VANTAA

The City of Vantaa is the fourth largest city in Finland and resides in the Helsinki Metropolitan Area. The city has provided contraceptive services for residents at public family planning clinics since 1975. These clinics are a part of the public health care services in Vantaa and service is free of charge for all residents and students in Vantaa. In 2013 and 2014, public contraceptive services were available at four different clinics, all close to residential areas and major commuting routes. Consultations at the clinics comprised contraceptive counseling, the initiation and removal of LARC methods, referral to specialized care for abortion, sterilization, and infertility, counseling on sexuality related matters, and the diagnosis and treatment of sexually transmitted infections. Waiting times for both nurse and doctor visits were moderate: one to four weeks depending on the visit type and clinic. Same-day insertions of LARC methods were possible with the available stocks of LARC methods at the clinics. The employees are general practitioners and health care professionals with special interest, education and experience in the field. In Vantaa, pre- and post-abortion care is also centralized in these clinics, also guaranteeing high-quality contraceptive counseling during this period.

As a marker of easy access, almost one-fifth of women of reproductive age in Vantaa used the public contraceptive services during 2013–2014. The
younger age groups were slightly overrepresented among service users: one out of four women aged 15–24 years visited a family planning clinic in Vantaa in 2014 (1,400 visitors aged 15–19 years / 6,000 women in this age group, and 2,100 visitors aged 20–24 years / 6,800 women).

Since January 1, 2013, all women in Vantaa have been eligible to receive their first LARC method free of charge at public family planning clinics. As the DMPA injectable is rarely used in Finland, only intrauterine contraception and hormonal implants were provided. The public program aimed to reduce the rate of induced abortions by increasing use of LARC methods. The program was designed to reach all women equally, without targeting risk groups. Resources for method supplies were the only resources appended to the family planning clinics. All other services at the clinics remained unchanged, including the provision of three months of short-acting reversible contraception (i.e. pills, patches, and rings) free of charge when starting a new method or switching method due to adverse effects, and nine months of short-acting methods free of charge for women under the age of 20. Also, there was no change in legislation during this time. When the new LARC program was launched, residents in Vantaa were informed of the new benefit through announcements in the local newspaper and on the city’s official web page. Women were also informed at counseling visits. However, there was no structural protocol or check-list regarding when and how to inform clients of the new program.

The following LARC methods were provided free of charge during 2013–2014: the 52-mg levonorgestrel-releasing intrauterine system (LNG-IUS, Mirena®, Bayer Healthcare AG, Turku, Finland), the 13.5-mg LNG-IUS (Jaydess®, as of 1st January 2014, Bayer), a 380-mm² copper intrauterine device (Cu-IUD, Nova-T®, Bayer), the etonogestrel contraceptive implant (Nexplanon®, MSD Finland Oy, Espoo, Finland) and the two-rod levonorgestrel contraceptive implant (Jadelle®, Bayer).

4.3 STUDY DESIGN

For this thesis, a new register-based cohort was established, with data from electronic health records and national registers.

**Study I** investigated factors predicting LARC initiation among eligible women using public family planning clinic services.

**Study II** evaluated the need for induced abortion during follow-up. Women using and not using the public family planning services and either initiating or not initiating a free-of-charge LARC method were compared.

**Study III** was a time-series study on the aggregated level, assessing the change in mean monthly rates of LARC uptake and induced abortions in Vantaa. The neighboring municipality of Espoo served as a control site without free-of-charge LARC provision to control for factors unrelated to the public
LARC program that could affect local abortion rates, concurrently with the intervention.

Hereafter, intervention refers to the public LARC program in Vantaa. Accordingly, pre-intervention and post-intervention refer to the time before and after the implementation of the public program.

### 4.3.1 DEFINING STUDY GROUPS FOR STUDIES I AND II

The complete study population for this thesis research comprised the entire female population aged 15–44 years living in Vantaa during 2013–2014, and eligible for a free-of-charge LARC method: a total of 49,489 women. The formation of the complete study population is presented in Box C.

Only a woman’s first LARC method is provided free of charge, and women with previous use were not therefore entitled to a free LARC. Previous users were identified from electronic health records according to at least one of the following criteria: initiation or removal of a LARC method during the years 2000–2013; removal of a LARC method after January 1, 2013, without a preceding insertion; or initiation of a LARC method that was not free of charge in 2013 or 2014. Health care providers at the public clinics trusted the women’s statements regarding previous LARC use that was not identifiable in the electronic health records, e.g. with initiations and removals at private clinics or in other municipalities. Hence, if a woman chose to lie on the matter, she could obtain a LARC method free of charge despite earlier use.

No private clinics provided LARC methods free of charge during the study period, and LARC initiations at private clinics were not therefore included.

LARC insertions among women younger than 15 years of age are very rare: only two such insertions were recorded during 2013–2014. Among women over the age of 45, the use of specifically the LNG-IUS for therapeutic reasons increases. Thus, we defined the age group of study subjects as 15–44 years to capture the contraceptive use of LARC methods. For the same reason, we excluded women with permanent contraception.

| Eligible for a LARC method free of charge.  
| Aged between 15 and 44 years. |
| **Exclusion criteria** | Age younger than 15 years or over 45 years.  
| Previous use of a LARC method. |

**Box C.** Formation of the complete study population.
The study subjects from the complete study population were defined as either service users or non-service users. Service users were further allocated to two study groups according to LARC choice and non-service users to two control groups as follows:

1. **Service users.** Women using the public family planning clinic services during 2013–2014 and eligible for a free-of-charge LARC method.

   a. **Controls matched to the LARC group.** A control group for group 1a, obtained by age matching with a ratio of 1:3 from non-service users.
   b. **Controls matched to the non-LARC group.** A control group for group 1b, obtained by age matching with a ratio of 1:3 from non-service users.

In study I, only service users (groups 1a and 1b) were assessed. In Study II, control groups consisting of non-service users (groups 2a and 2b) were used in addition to groups 1a and 1b to facilitate comparisons with the general population. The formation of the study groups is presented in Figure 5.

### 4.3.2 DEFINING STUDY ENTRY AND THE FOLLOW-UP TIME FOR STUDIES I AND II

The study participants gradually entered the study during the years 2013–2014, according to the study group. Women in the LARC group entered the study on the date of insertion of the free-of-charge LARC. Women in the non-LARC group entered the study at the date of the first visit to a public family planning clinic during 2013–2014. Women in the two age-matched control groups entered the study on the same date as the participant with whom they were matched. If a woman in any of the study groups was pregnant on the date of study entry (referred to as a baseline pregnancy), she was set to enter the study 30 days after the day the pregnancy ended, either in delivery or induced abortion. If the study entry date after such a pregnancy was in 2015, the woman was not included in the study.

The end of follow-up was defined as the first of the following events: the beginning of a pregnancy ending in abortion, the beginning of a pregnancy ending in birth, the date of moving abroad from Vantaa, the date of sterilization,
or on February 28, 2016. This date was chosen to ensure that all pregnancies ending in 2016 were reliably captured.

Figure 5. Flow chart displaying the formation of study groups for Studies I and II. LARC: long-acting reversible contraceptive.
4.4 THE DATA AND ITS SOURCES

Finland and the other Nordic countries are known for their complete and well-validated national registers (Gissler and Shelley, 2002, Gissler et al., 1996, Heino et al., 2017, Sund, 2012). All Finnish residents can be identified in these registers by means of a unique personal identification code. Such codes have been assigned for every permanent resident in Finland since the late 1960s. It is mandatory to report, for example, births, induced abortions, hospital discharge diagnosis, and some infectious diseases (Finlex, 1986, 1989). Thus, these registers provide researchers with comprehensive information on a large variety of sociodemographic background variables, as well as on outcomes, and facilitates the follow-up of large population cohorts. All data are gathered continuously, and independently of any research questions or designs.

Data from three different register-keeping authorities were used for this doctoral study: the City of Vantaa, the Finnish Institute for Health and Welfare, and Statistics Finland. In addition to these national registers, we used structured electronic health records (EHR) to obtain information on a variety of both confounding and outcome variables. Data were obtained at both the aggregated level for the time-series analysis and on the individual level for the cohort studies.

Table 8 presents the registers used and how variables were obtained and computed.

4.4.1 VARIABLES

The number of women aged 15–44 during 2013–2014 and their personal identification codes were obtained from the population register of Vantaa, together with the date of death or move abroad from Vantaa. Age at the start of follow-up was computed from the date of birth and date of the start of follow-up.

Data on visits to public family planning clinics in Vantaa, and on LARC method initiation during these visits, were collected from the EHR, which is used at all public clinics in Vantaa. All women who received a free-of-charge LARC at a public clinic in 2013–2014 were identified. All LARC initiations are registered in Vantaa’s health records using a procedure code, and registration entitles general practitioners to a minor pay supplement. The procedure code facilitates the identification of LARC insertions in the health records. The health records with a recorded LARC insertion were manually reviewed by three members of the research team to identify all free-of-charge LARC insertions. Altogether, 50 LARC insertions were reviewed by more than one researcher to confirm the evaluation, without any discrepancy. Data on visits to public clinics were also used to compute a variable on previous visits to public family planning clinics, to allow adjustment for recent contraceptive counselling.
Information on socio-demographic characteristics, as well as on events of outcomes or censoring events during follow-up, were gathered from many different registers (Table 8). We combined information from these registers based on the personal identification code. The education variable was transformed from nine-level educational data into a binary variable of elementary education vs. more than elementary education, which in Finland encompasses nine years of education. Not being a native speaker of Finnish or Swedish, the two national languages in Finland, was used as a proxy for belonging to a minority.

Cohabitation is not registered in Finnish registers; hence, we used a binary variable of being married or not. Participants were allocated to four groups regarding their socioeconomic status based on the national classification criteria of Statistics Finland: upper-level employees, lower-level employees, manual workers, and other, a group consisting of farmers, students, unemployed, retired, and housewives. Participants with an unknown socioeconomic status do not have an education or a history of employment in Finland. Additionally, variables on the obstetric and gynecological history were used, as well as on the history of sexually transmitted infections (STI).

The time-series data included data on 192 months or time points, from January 2000 to December 2015. Thus, the data comprised 156 pre-intervention time points and 36 post-intervention time points. In the time-series data, all variables were computed as rates among the female population in Vantaa: abortions, LARC insertions, and educational level per 1000 women in the corresponding age group, poverty as the proportion of residents living in the lowest income decile, and unemployment as the proportion of unemployed women in Vantaa aged 18–64 years.
## Materials and methods

Table 8. Data sources and formed variables.

<table>
<thead>
<tr>
<th>Register keeping authority</th>
<th>Register; Description</th>
<th>Information retrieved</th>
<th>Computed Variable</th>
<th>Variable type</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Vantaa</td>
<td>Vantaa Population Register; Information on all residents in Vantaa</td>
<td>Number of all women in Vantaa aged 15–44 years in 2013–2014</td>
<td>Number of women in each age group</td>
<td>Numerical/Time series</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date of birth</td>
<td>Age at the start of follow-up</td>
<td>Numerical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marital status</td>
<td>Being married</td>
<td>Binominal yes/no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Native language</td>
<td>Native language (Swedish or Finnish)</td>
<td>Binominal yes/no</td>
</tr>
<tr>
<td></td>
<td>Graphic FinStar; Electronic health record with information on visits to public health centers</td>
<td>Date of visit</td>
<td>Age at start of follow-up</td>
<td>Numerical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date of LARC insertion</td>
<td>Start of follow-up</td>
<td>Numerical/Date</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Whether the LARC method was provided free of charge</td>
<td>Cost of LARC method</td>
<td>Numerical/Date</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LARC method</td>
<td>Method type: Cu-IUD/LNG-IUS 52 mg/LNG-IUS 13.5 mg/ENG Implant, LNG 2-rod Implant</td>
<td>Categorical: four method types</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date of previous visit to contraception clinic</td>
<td>No visit to a contraception clinic within two years before start of follow-up</td>
<td>Binominal yes/no</td>
</tr>
<tr>
<td>Finnish Institute for Health and Welfare</td>
<td>Medical Birth Register (since 1987); Data on both mother and child, from all births with gestational age at least 22 weeks.</td>
<td>Date(s) of delivery(ies)</td>
<td>History of delivery at start of follow-up</td>
<td>Binominal yes/no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gestational week</td>
<td>Date of first delivery in follow-up</td>
<td>Numerical/date</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Date of gestation</td>
<td>Numerical/Date</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pregnant at start of follow-up</td>
<td>Binominal</td>
</tr>
</tbody>
</table>

Abbreviations: LARC: long-acting reversible contraception, Cu-IUD: copper intra-uterine device, LNG-IUS: levonorgestrel-releasing intrauterine system, ENG: etonogestrel, LNG: levonorgestrel
Table 8. Continued from previous page. Data sources and formed variables.

<table>
<thead>
<tr>
<th>Register keeping authority</th>
<th>Register; Description</th>
<th>Information retrieved</th>
<th>Computed Variable</th>
<th>Variable type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finnish Institute for Health and Welfare</td>
<td>Register of Induced Abortions (since 1983); Contains information on all pregnancies ending in induced abortion.</td>
<td>Date(s) of induced abortion(s)</td>
<td>History of abortion at start of follow-up</td>
<td>Binomial yes/no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gestational week</td>
<td>Date of first abortion in follow-up</td>
<td>Numerical/Date</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Date of gestation</td>
<td>Numerical/Date</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pregnant at start of follow-up</td>
<td>Binomial</td>
</tr>
<tr>
<td>Register on Sterilizations (since 1987); Data on all sterilizations in Finland.</td>
<td>Date of sterilization</td>
<td>Sterilized at start of follow-up</td>
<td>Binomial yes/no</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date of sterilization in follow-up</td>
<td>Numerical/Date</td>
<td></td>
</tr>
<tr>
<td>Register on Infectious Diseases (since 1995); Data on specified infectious diseases.</td>
<td>Date of diagnosis of STI *</td>
<td>STI within two years before start of follow-up</td>
<td>Binomial yes/no</td>
<td></td>
</tr>
<tr>
<td>Hospital Discharge Register (since 1969); Information on in-patient care in both primary and specialized care and out-patient visits to specialized care units.</td>
<td>Date of diagnosis (ICD-10: N80, N92, N94)</td>
<td>Diagnosis within two years before start of follow-up</td>
<td>Binomial yes/no for each diagnosis</td>
<td></td>
</tr>
<tr>
<td>Primary Care Register (since 2011); Information on out-patient visits to primary health care units.</td>
<td>Date of diagnosis (ICD-10: N80, N92, N94)</td>
<td>Diagnosis within two years before start of follow-up</td>
<td>Binomial yes/no for each diagnosis</td>
<td></td>
</tr>
<tr>
<td>Statistics Finland</td>
<td>The Register of Completed Education and Degrees</td>
<td>Educational level</td>
<td>Having more than elementary education</td>
<td>Binomial yes/no</td>
</tr>
<tr>
<td></td>
<td>Income distribution statistics</td>
<td>Poverty level</td>
<td>Proportion of women in each age-group with no more than elementary education</td>
<td>Numerical/Time series</td>
</tr>
<tr>
<td></td>
<td>Employment statistics</td>
<td>Unemployment</td>
<td>Proportion of residents living in the lowest income decile</td>
<td>Numerical/Time series</td>
</tr>
<tr>
<td></td>
<td>Socio-economic status</td>
<td>Socio-economic status</td>
<td>Proportion of women aged 18-64 being unemployed.</td>
<td>Numerical/Time series</td>
</tr>
</tbody>
</table>

Abbreviations: STI: Sexually transmitted infection, ICD-10: International Statistical Classification of Diseases and Related Health Problems, 10th revision.

* Pathogens *Chlamydia trachomatis*, *Neisseria gonorrhoea*, *Treponema pallidum*. * Upper-level employees, lower-level employees, manual workers, other (farmers, students, unemployed, retired, housewives), unknown (young, or without work or educational history in Finland)
4.5 STATISTICAL ANALYSIS

4.5.1 DESCRIPTIVE MEASURES
The two LNG-IUSs and the two contraceptive implants were combined for all analyses regarding predictors of LARC initiation (Study I), and all LARC methods were combined to evaluate the need for induced abortion and changes in the rates of LARC initiations and induced abortions on the population level (Studies II and III).

Based on clinical evaluation and previous studies, age was set as a three-category variable of adolescents (15- to 19-year-olds), young adults (20- to 24-year-olds) and adults (25- to 44-year-olds). However, fitting a restricted cubic spline of age towards choosing to initiate a LARC method displayed a non-linear association (P < 0.001). Hence, when evaluating predictors of LARC initiations, a four-category age variable was used: 15- to 19-year-olds, 20- to 24-year-olds, 25- to 29-year-olds and 30- to 44-year-olds.

The median age and frequencies for all categorical variables were calculated among the complete study population, in the four study groups, and according to LARC method choice. In Study I, the same calculations were repeated in the four age groups, as there was evidence of interaction between categorical age and choosing to initiate a LARC method. The distributions of continuous and categorical data were compared between the study groups. For continuous variables, the comparison was made with the Mann-Whitney U-test or Kruskall-Wallis test, and for categorical variables with Pearson’s chi-squared test. For variables with small expected numbers, Fisher’s exact test was used instead. In all analyses, p < 0.05 was considered as statistically significant.

4.5.2 IDENTIFYING FACTORS PREDICTIVE OF INITIATING A LARC METHOD USING LOGISTIC REGRESSION (STUDY I)
To identify factors associated with choosing a LARC method free of charge, logistic regression models were used to obtain odds ratios with 95% confidence intervals. In the first step, seven possible predictors of LARC use were assessed based on findings from previous studies: age, history of delivery, history of abortion, marital status, educational level, socioeconomic status, and belonging to a minority (not being a native speaker of the national languages).

To select which variables to include in the multivariate model, candidate predictors were eliminated using backward elimination with Akaike’s information criterion (AIC) as a stopping rule, i.e. a decreasing AIC for an improved model. Furthermore, excluded variables were reinserted one by one and all together to further check whether including these variables improved
the model (Lawless and Singhal, 1978). After this model selection procedure, the predictive variables included in the multivariate model were categorical age, history of delivery, history of abortion, and marital status. Educational level, socioeconomic status, and native language did not improve the model, and these variables were thus left out.

To evaluate the association of gynecological morbidity with LARC initiation, the following variables were included in the model to assess whether they would further improve the model: diagnosis of abnormal uterine bleeding, diagnosis of dysmenorrhea, diagnosis of a sexually transmitted infection by Chlamydia trachomatis, Neisseria gonorrhoea, or Treponema pallidum, and no previous visits to public family planning clinics. Only diagnoses and visits during two years prior to the start of study entry were included, as a longer medical history would not be relevant for the youngest age group and recent diagnoses are likely to be stronger predictors of LARC initiation. Although data on the diagnosis of endometriosis were available, only 35 women living in Vantaa had an endometriosis diagnosis in the Hospital Discharge Register and the Primary Care register during 2013–2014, and the diagnosis of endometriosis was therefore not included in the model. The model selection procedure described above was repeated with the gynecological morbidity variables to obtain the final regression model. Diagnosed dysmenorrhea and not having visited a public family planning clinic within two years before study entry improved the model and were included in the final multivariate regression model. The history of sexually transmitted infection and abnormal uterine bleeding did not improve the model and were left out.

Furthermore, interaction models including categorical age and each other predictive variable were estimated, as the need for and use of contraceptives varies with age. These models revealed significant interaction with categorical age and a history of delivery, abortion, dysmenorrhea, and no visit within two years. Thus, the main model was further stratified by the four age categories.

4.5.3 ASSESSING THE NEED FOR INDUCED ABORTION USING SURVIVAL ANALYSIS (STUDY II)

The crude incidence rate of abortions per 1000 women-years was calculated as the number of pregnancies ending in an induced abortion divided by the women-years accumulated during follow-up. Univariate Poisson regression models with the log of women-years as offset were used to assess the difference in abortion rates as crude rate ratios (RR) with 95% confidence intervals for service users compared to non-service users. The same analysis was repeated for comparisons between the two service-user groups, i.e. the LARC group and the non-LARC group. Furthermore, both service-user groups were separately compared with their corresponding age-matched control group of non-service users (see section 4.3.1). Survival curves for the need of induced abortion during follow-up were assessed using Kaplan-Meier estimates.
Materials and methods

First, previously identified risk factors for unintended pregnancy and induced abortion were assessed as potential confounders: age at the start of follow-up, marital status, socio-economic status, speaking a national language as the native language, level of education, and prior births and abortions. These confounders were assessed using univariate analysis, with all these covariates being associated with induced abortion (p < 0.05). The final multivariate Poisson regression model was therefore formed through a manual forward and backward selection process to examine the effect of each candidate covariate. The selection of covariates was guided by the statistical significance of their effect on the outcome variable (p < 0.05) and with information loss measured by the difference in AIC. The assumption of equal mean and variance was met for the Poisson regression models.

4.5.3.1 Managing the risk of immortal time bias
Women in the LARC group could have attended a family planning clinic before the decision to initiate a free-of-charge LARC method. Hence, the comparison between the LARC group and the non-LARC group could be susceptible to time-related bias, as women in the LARC group had to “survive” for a longer time without the event of interest – induced abortion – to be able to enter the study. To evaluate the potential impact of immortal time bias (Targownik and Suissa, 2015), sensitivity analysis was performed by adding the women-years that were accumulated for individuals in the LARC group from the possible first visit to a family planning clinic until the LARC initiation visit to the women-years of the non-LARC group.

4.5.4 ESTIMATING THE CHANGE IN LARC INITIATION AND RATES OF INDUCED ABORTION WITH TIME SERIES ANALYSIS (STUDY III)
Interrupted time-series methods were used to examine specific time-dependent properties of both LARC initiations and abortions. Time-series methods permit taking the pre-intervention level and trend into account when comparing outcome measures between different time periods (Bernal et al., 2017, Biglan et al., 2000, Kontopantelis et al., 2015, Zeger et al., 2006). The hypothesis was tested in three steps (Figure 6).

In all three steps, linear regression was used to assess the difference in steady state means before and after the intervention on January 1, 2013. The first step assessed whether or not there was a change in the steady state mean of the LARC method initiation rate following the introduction of the LARC program. In the second step, the analysis was repeated for the abortion rate time series, while at the same time controlling for the abortion rate time series in Espoo. In the third step, the LARC method initiation rate was included as an explanatory variable to study its effect on the abortion rate in Vantaa. To explore whether the LARC uptake mediated the effect of the intervention on
the abortion rate, a co-breaking test was conducted (Hendry and Massmann, 2007).

Figure 6. The three steps of hypothesis testing in the time-series analysis.
Reproduced with permission from AJPH (Gyllenberg et al., 2018a).

An indicator variable for the intervention, taking the value of zero before the introduction of the free-of-charge LARC program in January 1st, 2013, and one thereafter, was used to model a break in the mean. It was assumed that the intervention had an immediate effect on the LARC initiation rate, i.e. that LARC uptake would increase immediately after the implementation of the free-of-charge LARC program, but with a delayed effect on the abortion rate, as pregnancies starting after the start of the program could not be terminated without some time passing. The lag with the best fit turned out to be three months. Leads of up to a year were also assessed, but these only reduced the fit. The intervention indicator was thus included in the regression model at the precise time point in Step 1 and at three months after the true intervention in Step 2. In the co-breaking test, the indicator variable was used to test whether the increase in the LARC initiation rate was the underlying cause for the reduction in the abortion rate. In this case, the indicator variable would no longer be significant in this model, whereas a significant result would suggest that other factors were at least in part responsible for the break in the abortion rate time series.

In addition to the variables of confounding factors (education, unemployment, low income, and the abortion rate in Espoo in Step 2), 12 lags of each variable as well as seasonal dummy variables were included to adjust for monthly variation in the full regression models. As it was difficult to form a precise *a priori* theory for the lag structure, automatic model selection was used to obtain a parsimonious model from the initially over-parametrized system (Hendry and Krolzig, 2005). Autoregressive terms were included as additional regressors to allow for stochastic trends to capture possible breaks and trends in the data other than those induced by the intervention (Hamilton, 1994, Zeger et al., 2006). This is important as a tool to determine whether there is evidence of an external event affecting either the uptake of LARC
methods or the rate of induced abortions. Additionally, using autoregressive terms also corrects for serial correlation, i.e. the situation where the outcome at one time point is correlated with the outcome at one or more previous time points. Autoregressive terms also capture transition dynamics from one steady state to another, such as temporary changes in slope, while using deterministic trend terms can result in unrealistic predictions, for instance, that the rate of induced abortions becomes negative in future periods.

**4.5.4.1 Evaluation of costs**
The costs of this public free-of-charge LARC program were evaluated by comparing the costs of the LARC methods provided free of charge with the savings accountable to the abortions averted through the program. The City of Vantaa is responsible for both the costs of services at public family planning clinics (including method prices) and the costs of induced abortion. Of all abortions in Finland in 2013, 95% were medically induced (Heino et al., 2014). Women only pay a minor out-patient fee for a medical abortion, while the hospital bills the referring municipality for the remaining costs (€991 for a medically induced abortion in 2013–2014 (Kapiainen et al., 2014)). The number of LARC methods ordered by the City of Vantaa during 2013–2015 and the method prices were obtained from the Central Hospital Pharmacy (3,398 methods in total, with an average price of €104 per method). Only direct costs of LARC methods and estimated savings from averted abortions were included, as no additional resources were appointed to the family planning clinics to support the LARC program. A requirement of the economic evaluation of the program was that the time series of birth rates would remain stable throughout the study period, and that the intervention indicator variable would be insignificant when modeling birth rates.

**4.5.5 STATISTICAL SOFTWARE**
The analyses for Studies I and II were conducted using R statistical software (version 3.5.3), and the analyses for Study III using Ox Professional, version 6.10 for Windows (J.A. Doornik, 1994-2010).
5 RESULTS

5.1 STUDY POPULATION

Of all 54,795 women aged 15 to 44 years living in Vantaa during 2013–2014, a total of 49,489 were eligible for a free-of-charge LARC method. Altogether, 9,699 women used the public family planning clinic services during the follow-up. Among these, 2,035 women initiated a free-of-charge LARC method, i.e. 21% of all eligible women using the services in 2013–2014.

Figure 7 presents a summary of selected demographic and gynecological characteristics among the study population, displayed in three groups: women not using the public family planning clinic services (non-service users), women using the services but not initiating a free-of-charge LARC method (non-LARC group), and women using the services and initiating a free-of-charge LARC method (LARC group, section 4.3.1).

Compared to service users without LARC use, women initiating a free-of-charge LARC method were older (proportion of women in the highest age group 43% vs. 25%), more often parous (64% vs. 24%), and more often had a history of induced abortion (24% vs. 14%). LARC initiators were also more often married (40% vs. 20%). All of these differences were significant at \( p < 0.001 \), as were the differences in educational level, socioeconomic status, native language, and previous visits to a public family planning clinic. Regarding the history of gynecological morbidity, fewer women in the free-of-charge LARC group than among service users without LARC use had experienced an STI within two years prior to study entry (3% vs. 4%, \( p = 0.006 \)).
Results

Figure 7. Frequencies (%) of selected characteristics among the study population. Note: Only the most common socioeconomic status is displayed. Abbreviations: LARC: long-acting reversible contraception, STI: sexually transmitted infection.
5.1.1 LARC METHODS INITIATED FREE OF CHARGE

Free-of-charge LARC methods were initiated as follows: 1,203 women chose an LNG-IUS (124 of these the 13.5-mg LNG-IUS, only available in 2014), 646 women chose a contraceptive implant (637 ENG implants and 9 LNG two-rod implants), and 186 women chose the Cu-IUD. The preferred LARC method varied between the age groups (Figure 8). Among women initiating a free-of-charge LARC method, 77% of the 15–19-year-old women chose a contraceptive implant, while implants and LNG-IUSs were equally popular among 20–24-year-old women (44% vs. 46% of initiated methods, respectively). In the two older age groups, the LNG-IUSs were clearly the most popular choice, constituting 62% of the free-of-charge methods initiated by 25–29-year-old women and 75% of the methods initiated by 30–44-year-old women.

![Figure 8. Distribution of free-of-charge LARC methods in the four age groups.](image)

Note: Implants comprise both the etonogestrel implant and the levonorgestrel two-rod implant. Abbreviations: Cu-IUD copper intra-uterine device, LNG-IUS: levonorgestrel intrauterine system.
### 5.2 PREDICTORS OF LARC INITIATION (STUDY I)

Five factors were found to associate with initiating a free-of-charge LARC method and were thus included in the final regression model: categorical age 20–24 years, history of induced abortion, history of delivery, being married, and not having visited a public family planning clinic within two years preceding study entry. A history of delivery increased the odds of initiating a free-of-charge LARC method the most (aOR 5.39, 95% CI 4.69–6.19), followed by a history of induced abortion and being married (aOR 1.39, 95% CI 1.21–1.58 and aOR 1.23, 95% CI 1.08–1.40, respectively). The results from the multivariate model are presented in Figure 9, together with crude ORs from the univariate models of variables included in the multivariate regression model.

<table>
<thead>
<tr>
<th>Predictive Variable</th>
<th>OR</th>
<th>Adjusted OR</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group 15–19 Crude</td>
<td>0.28</td>
<td>1.15</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age group 20–24 Crude</td>
<td>0.42</td>
<td>1.25</td>
<td>&lt;0.001</td>
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<tr>
<td>Age group 25–29 Crude</td>
<td>0.68</td>
<td>1.08</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>History of delivery Crude</td>
<td>5.76</td>
<td>5.39</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>History of induced abortion Crude</td>
<td>1.85</td>
<td>1.39</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Married Crude</td>
<td>2.55</td>
<td>1.54</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No previous visit Crude</td>
<td>1.68</td>
<td>1.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>History of dysmenorrhea Crude</td>
<td>1.12</td>
<td>1.40</td>
<td>0.08</td>
</tr>
</tbody>
</table>

**Figure 9.** Forest plot of crude and adjusted odds ratios (OR) for initiating a free-of-charge LARC method, together with 95% confidence intervals (whiskers) and p-values. Reproduced with permission from Contraception (Gyllenberg et al., 2020).

The three younger age categories (15–19-year-olds, 20–24-year-olds and 25–29-year-olds) were associated with not initiating a LARC method in crude models compared to the reference group of 30–44-year-olds (i.e. OR below 1), but associated with initiating LARCs after adjustment. This association was strongest and statistically significant among 20–24-year-old women, compared to the reference group of 30–44-year-olds. Closer examination revealed that adding history of delivery to the model with categorical age induced the shift in association.

Evaluating interactions between categorical age and the other predictors revealed significant interactions between categorical age and history of delivery (p = 0.006 for 15–19-year-olds, p = 0.001 for 20–24-year-olds, and p < 0.001 for 25–29-year-olds), history of induced abortion (p < 0.001 for 15–
19-year-olds and \( p = 0.005 \) for 20–24-year-olds), no previous visit to a family planning clinic \((p < 0.001 \) for 15–19-year-olds and \( p = 0.03 \) for 20–24-year-olds), and history of dysmenorrhea diagnosis \((p = 0.01 \) for 15–19-year-olds and \( p < 0.001 \) for 20–24-year-olds). According to the analysis plan, the regression model was thus repeated in the four age groups.

History of delivery presented the highest ORs for initiating a free-of-charge LARC method of all variables and in all age groups. Among 15–19-year-olds with a history of delivery, the OR for initiating a free-of-charge LARC method was 10.82 (95% CI 5.12–23.35), among 20–24-year-olds 6.40 (95% CI 4.94–8.31), among 25–29-year-olds 6.68 (95% CI 5.22–8.60), and among 30–44-year-olds 3.63 (95% CI 2.92–4.55).

History of induced abortion was only significantly associated with choosing a LARC method among 15–19- and 20–24-year-olds \((\text{aOR} 3.16, 95\% \text{ CI} 1.91–5.11 \) and \( \text{aOR} 1.82, 95\% \text{ CI} 1.39–2.37 \), respectively). Among 20–24-year-olds, a prior diagnosis of dysmenorrhea was associated with choosing a LARC method \((\text{aOR} 3.78, 95\% \text{ CI} 2.06–6.73)\). Being a new customer at the family planning clinic (i.e. having no previous visit) reduced the odds of choosing a free-of-charge LARC method in the youngest age group \((\text{OR} 0.73, 95\% \text{ CI} 0.55–0.97)\), but increased the odds in the three older groups.

### 5.3 NEED FOR INDUCED ABORTION (STUDY II)

The mean follow-up time in the survival analysis of the need for abortion was 2.0 years with a standard deviation of 0.7 years. Altogether, 78,500 person-years (PY) accumulated during the follow-up period between January 1, 2013, and February 28, 2016. Of these person-years, 58,472 were accounted for by the age-matched control groups of women not using family planning services (section 4.3.1). Among service users, 4,118 PY passed in the LARC group and 20,054 in the non-LARC group. In total, 996 women underwent an induced abortion, 243 of which were in the non-LARC group and 16 in the LARC group. The incidence rates of pregnancy ending in induced abortion per 1000 PY were 12.92 (95% CI 11.44–14.54) for service users and 12.60 for non-service users. The incidence rates among service users were 3.88 (95% CI 2.40–6.01) in the LARC group and 15.25 (95% CI 13.45–17.23) in the non-LARC group. In the corresponding control groups of age-matched non-service users, the figures were 11.10 (95% CI 9.33–13.11) and 12.97 (11.98–14.02), respectively. The survival curves based on Kaplan-Meier estimates of the probability of no need for induced abortion by study group are presented in Figure 10.
**Results**

![Survival curves](image)

**Figure 10.** Survival curves based on Kaplan-Meyer estimates of the probability of no need for induced abortion in the four study groups. 
Note: *P*-value for overall difference between survival curves obtained with the log-rank test. Abbreviations: LARC: long-acting reversible contraception. Reproduced with permission from Obstetrics & Gynecology (Gyllenberg et al., 2018b).

In assessing adjusted rate ratios (aRR) for induced abortion during the follow-up, five variables were included in the multivariate Poisson regression model: age, socioeconomic status, marital status, history of delivery, and history of induced abortion. The aRR for induced abortion was significantly lower in the LARC group compared to the non-LARC group (aRR 0.20, 95% CI 0.11–0.32), as well as compared to the corresponding age-matched control group (aRR 0.26, 95% CI 0.14–0.43). There was no difference in rates of induced abortion between the non-LARC group and the corresponding age-matched control group (aRR 1.01, 95% CI 0.87–1.18).

In the sensitivity analysis addressing the potential immortal time bias, a total of 400 PYs were appointed to the non-LARC group. These years were accumulated by the time between women’s first visit to a public family planning clinic and the free-of-charge LARC visit, i.e. by women in the LARC group but not accounted for as person-years in the LARC group follow-up. With these extra women-years in the denominator, the incidence rate in the non-LARC group remained similar to that in the main analysis (14.88, 95% CI 13.12–16.80 vs. 15.25, 95% CI 13.45–17.23).
5.4 CHANGES IN RATES OF LARC INITIATIONS AND INDUCED ABORTIONS (STUDY III)

During the time period from 2000–2015, birth rates at both the intervention site, Vantaa, and the control site, Espoo, were stable and stationary. During three years before the start of the free-of-charge LARC program on January 1, 2013, and three years after, the two cities were also similar regarding the included covariates: unemployment, low income, and elementary education.

The mean monthly rate of LARC initiations at public family planning clinics in Vantaa increased directly after the start of the free-of-charge LARC program, from 1.94 to 4.20 initiations per month in 1000 women aged 15–44 years. The adjusted rate ratio was 2.17 (95% CI 1.86–2.47). The mean rate of monthly LARC initiations increased in all three age groups: among 15- to 19-year-olds from 0.38 to 1.39 (aRR 3.67, 95% CI 2.54–4.80), among 20- to 24-year-olds from 1.44 to 3.72 (aRR 2.59, 95% CI 1.81–3.37), and among 25- to 44-year-olds from 2.36 to 4.27 (RR 1.81, 95% CI 1.44–2.18). Figure 1 presents the mean monthly LARC initiation rates in Vantaa per 1000 women in the three age groups, together with the steady-state mean estimates from the first model in the evaluation of population-level effects (Figure 6, step 1, section 4.5.4).

The mean monthly rate of induced abortions decreased in Vantaa with a lag of three months after the start of the free-of-charge LARC program. The pre-intervention mean rate of induced abortions was 1.10 per month in 1000 women aged 15–44 years, while the post-intervention mean rate was 0.92, with an adjusted rate ratio of 0.84 (95% CI 0.79–0.89). The monthly mean rate of induced abortions was reduced by 36% among 15–19-year-olds, from 1.32 to 0.84 (aRR 0.64, 95% CI 0.54–0.74). Among 20–24-year-olds, the mean monthly rate of induced abortions decreased by 15% from 1.99 to 1.70 (aRR 0.85, 95% CI 0.74–0.96). In the oldest age group of women aged 25–44 years, a non-significant reduction in the monthly rate of induced abortions of 6% was seen (mean rate decreased from 0.86 to 0.80, aRR 0.94, 95% CI 0.84–1.03). Figure 12 presents the crude monthly rates of induced abortions in the three age groups, together with the steady-state mean estimates from the second model in the evaluation of population-level effects (Figure 6, step 2, section 4.5.4).
Results

A. 15– to 19–year-olds

B. 20– to 24–year-olds

C. 25– to 44–year-olds

Figure 11. Monthly crude rates of LARC initiations (dots) per 1000 women in Vantaa, together with estimated pre- and post-intervention steady-state means (red line) and 95% confidence intervals (dashed line), in the three age groups (A–C).
Reproduced with permission from AJPH (Gyllenberg et al., 2018a).

A. 15– to 19–year-olds

B. 20– to 24–year-olds

C. 25– to 44–year-olds

Figure 12. Monthly crude rates of induced abortion (dots) per 1000 women in Vantaa, together with estimated pre- and post-intervention steady-state means (red line) and 95% confidence intervals (dashed line), in the three age groups (A–C).
Reproduced with permission from AJPH (Gyllenberg et al., 2018a).
In assessing the association of LARC initiation directly with the rate of induced abortions (Figure 6, step 3, section 4.5.4), there was a significant negative correlation between LARC initiations and induced abortions in all age groups. Thus, rates of induced abortions decreased as LARC initiations rates increased. Using the LARC initiation rate as a covariate in modelling the rate of induced abortions, the indicator variable (representing the start of the free-of-charge LARC program) was no longer significant (\( p = 0.44 \) for the full sample, and 0.44, 0.94, and 0.77 in the three age groups, respectively). Thus, there was co-breaking between the time series of LARC initiation rates and the time series of abortion rates, indicating that increased LARC initiation was the mediator between the public LARC program and the reduction in rates of induced abortions.

### 5.4.1 COST EVALUATION

In the preliminary evaluation of economic aspects of the public LARC program, only costs and spending directly attributable to the methods provided were assessed. Comparing these costs and estimated spending for the three first years of the public program, the yearly net cost of the program was as follows: +€25,000 for 15–19-year-olds, +€0 for 20–24-year-olds, and -€67,000 for 25–44-year-olds.
6 DISCUSSION

Key findings

The program reached women with a history of delivery and induced abortion well, especially women under the age of 25 years.

Women initiating LARC methods had an 80% lower risk of induced abortion than women using public services but not initiating LARC methods, although being eligible for one free-of-charge.

The rate of LARC initiations increased immediately after the implementation of the program in all age groups, and the rate of induced abortions decreased after a 3-month lag among women under the age of 25 years.

Box D. Key findings from the studies in this thesis.

The main findings of the research constituting this thesis are presented in Box D. The evaluation of the public program in Vantaa demonstrated that initiation rates of long-acting reversible contraceptive (LARC) methods at public clinics more than doubled when cost was eliminated as a barrier to their initiation. While birth rates remained stable, the rate of induced abortions decreased in the population. Thus, the findings indicate that the rate of unintended pregnancy was reduced after the implementation of the program. The translation of science and evidence-based knowledge into practices is crucial when arranging health care services. The present research brings novel information on the effects of a specific public program, as investigated in this thesis from three different angles. First, information on the characteristics of women who chose a free-of-charge LARC method brings advice on potential new LARC users within such a program. Second, LARC initiation rates were examined to quantify the degree to which the initiation of these methods increased following the introduction of such a program. Finally, the subsequent change in rates of induced abortions was assessed as the need for induced abortions both among cohorts of service users and on the population level. This was done to evaluate whether the program was able to address, in part, an unmet need for family planning.
6.1 LARC INITIATION

Of all women using family planning clinic services in Vantaa in 2013–2014, 21% initiated a free-of-charge LARC method, which equals 4% of the entire female population eligible for a free-of-charge LARC. This is considerably less than in the CHOICE population, where 75% initiated a LARC method although all contraceptive methods were provided free of charge (McNicholas et al., 2014). However, in the CHOICE project, all participating women agreed to start a new contraceptive method, while in the real-life setting of the present study, visits comprised follow-up visits and counselling, in addition to initiation and method switching.

The type of LARC method a woman initiated varied by age group. The LNG-IUS was the most popular method among women aged 25 years and older, while among women aged 15 to 19 years initiating a LARC method, 77% chose a contraceptive implant. The results are in line with those of the CHOICE study, in which 63% of women aged 14–17 years initiating a LARC method chose a contraceptive implant (Mestad et al., 2011).

Of note is that the public program in Vantaa only provided a woman’s first LARC method free of charge and only at public clinics, and thus the identified number of women initiating LARCs did not capture the overall initiation or uptake of these methods.

6.1.1 PREDICTORS OF LARC INITIATION (STUDY I)

Among women using the public family planning services in Vantaa during 2013–2014, those with a history of delivery were more likely to initiate a free-of-charge LARC method than women without a history of delivery. This association has also been described in other studies (Nelson et al., 2019, Stumbar et al., 2019). In the present results, the difference between parous and nulliparous women was greatest among women aged 15–19 years. Among all 15–19-year old women with a history of delivery, 40% visited a public family planning clinic during the years 2013–2014, and 20% initiated a free-of-charge method. The highest odds for initiating a LARC method in all age groups were for being parous as compared to nulliparous.

A history of induced abortion increased the odds of initiating a free-of-charge LARC method among women under the age of 25, while it did not alter the probability of initiation among women in the older age groups. Previous studies have also shown discrepant results regarding the association between prior induced abortion and LARC initiation. In the CHOICE cohort, recent abortion increased the odds of initiating LARC methods, but only when provided immediately post-abortion (Madden et al., 2011). In a study among women seeking post-abortion care in Colorado, those with a history of induced abortion were less likely to initiate a LARC method (Fang et al., 2018). According to national statistics in Finland, almost half of women undergoing an induced abortion intend to initiate IUD contraception, but at the same time,
the proportion of induced abortions that are repeat abortions are on the rise in Finland, representing almost 40% of all induced abortions in 2018 (Heino and Gissler, 2019). LARC methods have been shown to effectively decrease the risk of repeat abortion (Pohjoranta et al., 2015). Hence, it is somewhat concerning that women over 25 years of age in this present study population did not lean towards LARC contraception.

The high acceptance of LARC methods among women with a history of delivery or abortion may be explained at least in part by the Finnish health care system. After both delivery and abortion, all women are invited to a follow-up visit, which includes contraceptive counseling according to the Finnish national guidelines. According to a Finnish expert review, practically all women in Finland attend delivery follow-up visits (Perheentupa, 2004), while attendance at abortion follow-up visits is approximately 60% (Pohjoranta et al., 2011). In Vantaa, approximately 70% of women attended a post-abortion follow-up visit in 2014 according to statistics from the electronic health records. Thus, women with a history of delivery or induced abortion were already familiar with the public service system, which might have increased the probability of also using the public contraceptive services. In addition, women who had used the public services before were more likely to have been informed of the free-of-charge program.

Not having any previous visits to public family planning clinics increased the odds of initiating a LARC method for women aged 25 years or older. However, among women in the youngest age group, 15–19-year-olds, not being a former service user reduced the odds of initiating a LARC method. Thus, LARC initiation in this age group seems to require more than one visit, perhaps reflecting a greater need for information and contraceptive counselling before deciding on a method, and that adolescents might have difficulties in finding a pleasant contraceptive option. In addition, the number of adolescents receiving contraceptive counselling through the maternal services was lower than among older women, as delivery in this age group is less common.

Dysmenorrhea increased the odds of initiating free-of-charge LARCs only among women aged 20–24. This might be explained by the design of the free-of-charge program, i.e. that only a woman’s first LARC method was provided free of charge. If women with a history of dysmenorrhea are more likely to initiate LARC methods, those aged 25 or more are likely to already have used a LARC method prior to the start of the public program and were thus not eligible for a free-of-charge LARC.

To summarize, the public program in Vantaa reached women with characteristics similar to those with unintended pregnancy well, although the program was designed to reach women universally without targeting risk groups. This stresses the importance of universal contraceptive counselling, regardless of a woman’s characteristics.
6.1.2 CHANGES IN LARC INITIATION RATES (STUDY III)

The time series analyses demonstrated a significant increase in the monthly mean rates of LARC initiation in all age categories. Among 15–19-year-olds, the increase was almost four-fold, and among 20–24-year-olds more than 2.5-fold, while among 25–44-year-old women, the increase was nearly two-fold. Thus, the results imply that the free-of-charge program lowered the barrier to LARC use, especially among women under the age of 25, although initiation rates increased in all age groups.

In studies addressing the effect of the Affordable Care Act (ACA), which reduced or eliminated out-of-pocket expenses for all contraceptive methods for most insured women in the USA, little or no association with increased LARC initiation has been found (Bearak and Jones, 2017, Pace et al., 2016, Snyder et al., 2018). On the contrary, in studies assessing more comprehensive funding initiatives in the USA, the corresponding increases in LARC uptake have been higher than in ACA-only settings: LARC use increased from 5% to 19% in Colorado, from 1% to 15% in Iowa, and with an OR of 1.6 in Utah (Biggs et al., 2015, Ricketts et al., 2014, Sanders et al., 2018). In the CHOICE project, 75% of participant women initiated a LARC method (McNicholas et al., 2014).

Of note is that the ACA, CHOICE, and the contraceptive initiative in Utah offered all contraceptive methods free of charge, while the programs in Colorado and Iowa provided funding for contraceptive methods based on specific criteria such as the poverty level. However, neither of these studies were solely LARC programs, as the public program in Vantaa was. Nevertheless, the programs in Colorado, Utah, Iowa, and the CHOICE project all aimed at increasing LARC use, as did the program in Vantaa. In Colorado, the Colorado Family Planning Initiative expanded the provision of LARC methods at no cost as compared to other methods and increased staff training on insertion techniques (Ricketts et al., 2014). In Utah, multiple barriers to LARC use were removed by increasing staff education, stocking, same-day initiations, and increasing the provision of all methods free of charge (Sanders et al., 2018). In Iowa, access to LARC methods was increased by staff and community awareness campaigns, subsidized LARC methods, and offering LARC initiation at more times and locations (Biggs et al., 2015). In the CHOICE project, all participants obtained brief information on LARC methods (Secura et al., 2010). However, there was no evidence of increased LARC uptake at sites providing structured contraceptive counselling (Madden et al., 2013). The public LARC program in Vantaa did not include any modification of the contraceptive counselling process. However, the option of free-of-charge LARCs may have altered to whom health care professionals recommended LARC methods, although information on this matter is not available.

To conclude, funding for contraceptive methods appears to affect the initiation of the most effective contraceptive methods differently in different settings.


6.2 INDUCED ABORTIONS

6.2.1 PROBABILITY OF INDUCED ABORTION (STUDY II)
Survival analyses indicated that the rate of induced abortion was 80% lower among women who initiated a free-of-charge LARC method compared to women who were using public contraceptive services but did not initiate a LARC method despite being entitled to a method free of charge. Correspondingly, the rate of induced abortions was also almost 80% lower in the CHOICE population than the regional and national levels of induced abortions (Peipert et al., 2012). However, the study design in the CHOICE study did not allow for a formal comparison, as it did not include a control group.

Smaller reductions in rates of induced abortion have been reported among women in post-abortion care, where the initiation of LARC methods has been shown to reduce the need for repeat abortion by 50–60% (Baldwin and Edelman, 2013, Pohjoranta et al., 2015, Rodríguez et al., 2014).

There was no difference in rates of induced abortion among women using public family planning services while not initiating free-of-charge LARC methods compared to matched non-service users. Thus, attending a public family planning clinic without initiating a free-of-charge LARC method did not reduce the risk of induced abortion. Given that women initiating a LARC method share similar characteristics with women experiencing an unintended pregnancy (section 6.1.1.), their baseline risk for unintended pregnancy was presumably not very different from the risk among non-LARC service users. Thus, women using family planning services were found to be at risk of unintended pregnancy. The findings highlight the importance of contraceptive counseling, especially regarding the efficacy of various contraceptive methods.

6.2.2 CHANGES IN RATES OF INDUCED ABORTIONS (STUDY III)
Time series analysis demonstrated an association between the implementation of the program and decreased mean monthly rates of induced abortions. The overall reduction in monthly rates of induced abortions was 16%, with a 36% drop among 15–19-year-olds, 15% among 20–24-year-olds, and 6% among women aged 25–44. The increased rates of LARC initiations presented as a mediating factor for this reduction. In contrast, LARC use is also prevalent in Sweden (Lindh et al., 2017), but so are induced abortions (Singh et al., 2018). In Vantaa, although monthly LARC initiation rates increased in all age groups, the corresponding reduction in monthly rates of induced abortions was only significant among women under the age of 25.

In a cluster randomized clinical trial in the USA, public funding did associate with higher LARC uptake, but did not correspond with decreased rates of induced abortion (Thompson et al., 2016). On the contrary, when access and
the quality of service received attention together with a funding initiative, rates of induced abortions correspondingly decreased in Colorado. Evaluation of the Colorado Family Planning Initiative revealed that the rate of induced abortions among women aged 15–19 years declined in counties affected by the initiative, but also in counties that were not, with 34% vs. 29% declines in rates of induced abortions. On the contrary, induced abortion rates among 20–24-year-olds fell by 18% in affected counties, but were stable in counties without the initiative (Ricketts et al., 2014). In Iowa, state-wide rates of induced abortions fell by 23% after the implementation of a contraceptive program (Biggs et al., 2015). The declining trend in the abortion rate among teenagers has been associated with increased LARC usage in the same age group in the UK (Connolly et al., 2014).

Interestingly, the rate of induced abortions was already lower in Vantaa than in most parts of the world before 2013 (Figure 1, section 2.1.2). However, the results suggest that the removal of cost as a barrier to these effective methods further reduced the incidence of unintended pregnancy, even in this setting. Despite the low rates of induced abortions, there might be an unmet need for contraception in the population, and thus room to improve the services.

It is of note that this study ended in 2015, but according to national statistics from 2015–2018, the rates of induced abortions in Vantaa have remained stable between 8.7 and 9.1 / 1000 women (Finnish Institute for Health and Welfare).

### 6.3 ECONOMIC ASPECTS

The benefits of the public LARC program in Vantaa should not be evaluated on economic grounds only, as unintended pregnancy and induced abortion are associated with mental and physical challenges for the mothers as well as for their children (Brown SS, 1995, Tsui et al., 2010). However, the preliminary evaluation of direct costs and savings of the program seems promising. Among 15–19-year-olds, the estimated resources saved from reduced abortions exceeded the money spent on LARC methods, and among 20–24-year-olds the costs and savings were of equal amounts. This is in line with earlier studies on the cost efficiency of contraceptive methods and public programs (Foster et al., 2009, Mavranezouli and Larc Guideline Development Group, 2008, Trussell et al., 2013). Despite the two-fold higher uptake of LARC methods among women aged 25–44, there was no corresponding decrease in the rate of induced abortions in this age group and hence the cost balance was clearly unfavorable among women older than 25 years.
6.4 METHODOLOGICAL CONSIDERATIONS

6.4.1 SETTING-SPECIFIC CONSIDERATIONS

In Finland, over 40% of women of fertile age use modern contraceptive methods (Lindh et al., 2017), and the rate of induced abortions is one of the lowest in the developed world (10 abortions per 1000 15- to 49-year-old women in 2013 (Heino et al., 2014)). Therefore, Finland might not have been the most sensitive setting to study the effects of such a free-of-charge LARC program. Nevertheless, despite the high prevalence of use of modern contraception and low rates of induced abortions, the provision of free-of-charge LARC methods was associated with both increased LARC initiation rates and decreased rates of induced abortions.

The contraceptive services were well established and of high-quality in Vantaa before the study period. The services remained unchanged through the study period and were not altered by the research project. Multiple barriers to LARC use had already been addressed before the implementation of the free-of-charge program: same-day initiation was available upon request, the staff were continuously educated on eligibility and insertion techniques for LARC methods, and patients were counselled on all available methods, including LARCs. The City of Vantaa thus provided a setting to assess the effect of removing cost as a barrier to LARC use where other barriers were moderate. However, the magnitude of the results might not be as profound in settings with a different organization of contraceptive services, which might affect the generalizability of the results.

Addressing the effect size associated with the free-of-charge program in Vantaa also requires evaluation of the premises of the program. The public program starting in January 2013 provided only LARC methods free of charge. The majority of other reviewed funding programs provided all methods free of charge or at reduced costs, even though some programs gave special attention to LARC methods, e.g. through staff and patient education, counselling, and additional subsidization of these methods. In addition, providing only LARC methods free of charge clearly promotes their use, as it gives an economic incentive to women to initiate these methods. This might explain the upsurge in LARC uptake to some extent. Interestingly, the reduction in the rate of induced abortions in the present study was also more profound than in other studies.

A further limitation of the present research is that the potential change in counselling and recommendation regarding LARC methods in Vantaa was not measured, and the possible impact of a change in these processes could not therefore be evaluated.
6.4.2 OTHER METHODOLOGICAL CONSIDERATIONS

The strengths and limitations of the research of this thesis are presented in detail in Table 9. To summarize, the strengths include use of Finnish nationwide and regional data that are of high quality. Use of these registers allows the evaluation of complete populations, including adolescents, a group seldom included in trials on reproductive matters. The national Register of Induced Abortions is well validated and a reliable data source, also with respect to specific age groups (Heino et al., 2017). While electronic health records are not designed for research, they do bring new possibilities to previous register-based study designs (Casey et al., 2016).

The associations of the public LARC program with the rates of LARC initiations and induced abortions were assessed with time series analyses. Time-series methods are considered the strongest quasi-experimental design for estimating intervention effects in non-randomized settings (Penfold and Zhang, 2013). Interrupted times series have been shown to estimate the effects of interventions similarly to randomized study designs (Fretheim et al., 2015). In addition, the statistical modelling allowed for stochastic trends catching any underlying shifts and trends within the time series, and for autocorrelation.

The limitations also require attention. In these observational studies, there is always a risk of residual confounding, and limitations regarding causal inference might be present. Register-based data are not designed for research, and information that would be important from a researcher’s perspective is sometimes missing. Moreover, the Finnish registers only include events occurring in Finland, i.e. education, work history, and obstetric events abroad are not captured in these registers. Specific time series considerations include the time series only having one interruption. This holds the risk of another event possibly occurring at the same time as the public program and affecting the time series. Nevertheless, the findings from all steps of the hypothesis testing supported the increase in LARC initiations being the factor mediating the decline in rates of induced abortions.
Table 9. Strengths and limitations of the conducted research.

<table>
<thead>
<tr>
<th>Methodological issue</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete local population</td>
<td>Few previous studies with a complete population cohort.</td>
<td>Population was defined as women entitled to free-of-charge LARC, excluding women with previous use. Characteristics of non-service users were limited.</td>
</tr>
<tr>
<td>Real-world setting / Observational study</td>
<td>Improves external validity of the study.</td>
<td>Non-randomized design with risk of residual confounding. Effect of changes in contraceptive counselling could not be studied or controlled for. Duration of follow-up was short.</td>
</tr>
<tr>
<td>Setting-specific issues</td>
<td>Both contraception and abortion services remained stable throughout the study period. Presence of national guidelines enables stable quality of services. Few barriers to LARC initiation already prior to the free-of-charge program, as Vantaa has: - good access to services - equal services for all and frequently used services - consultations free of charge - possibility of same-day insertions - educated staff - good patient awareness, as reproductive health education is mandatory in elementary school</td>
<td>Assessing the impact of a free-of-charge program only in this setting, and only in one municipality. The findings may be unique to the City of Vantaa. The universal health care system in Finland differs from health care systems in many other countries.</td>
</tr>
<tr>
<td>Ecological study</td>
<td>Properties of a natural experiment: implementation of program independently of the research question/researchers. Makes assessing adolescents possible, a group difficult to include in clinical trials.</td>
<td>Cannot rule out potentially common underlying factors of both contraceptive choice and unintended pregnancy, which could have been addressed, e.g. with yearly cross-sectional surveys.</td>
</tr>
<tr>
<td>Sample size</td>
<td>A large sample size making it possible to identify more rare characteristics.</td>
<td>Small number of rare events (e.g. abortion among women initiating LARC contraception)</td>
</tr>
<tr>
<td>Time-series methods</td>
<td>Allows - control for underlying shifts or trends not related to the LARC program - autocorrelation</td>
<td>Only one interruption in the times series - possibility of a concurrent event</td>
</tr>
<tr>
<td>Economic evaluation</td>
<td>The same organization was responsible for resources spent on both LARC methods and induced abortions, which enables a comparison of direct costs and savings.</td>
<td>Only direct costs and savings were available, and no formal cost-benefit analysis could hence be conducted.</td>
</tr>
</tbody>
</table>

Abbreviations: LARC: long-acting reversible contraception. EHR: Electronic health records
Table 9. (Continued from previous page) Strengths and limitations of the conducted research.

<table>
<thead>
<tr>
<th>Methodological issue</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of the free-of-charge program: only a woman's first LARC method provided free of charge</td>
<td>Only new LARC users are included, supporting comparison of study groups without confounding of previous experience of LARC methods. Only LARC methods at public clinics were provided free of charge; thus, no data lacking due to the use of different EHRs in private clinics.</td>
<td>Prevalence of LARC methods in the study group not possible to evaluate.</td>
</tr>
<tr>
<td>Use of national registers</td>
<td>Makes the complete population setting possible. Allows linking to each individual in study groups. Allows precise inclusion criteria, and detailed adjustments for large cohorts. Potential errors (e.g. wrongly entered data) occurring completely at random regarding the research question. Low risk of losing participants to follow-up. Allows for investigating the history of gynecological diagnoses and sexually transmitted infections.</td>
<td>The researcher cannot affect the information that is gathered. Information not in the national registers: - cohabitation - race/ethnicity - education and work history abroad - births and abortions abroad - personal information such as pregnancy intention.</td>
</tr>
<tr>
<td>Use of local registers</td>
<td>Includes information not recorded in national registers: - native language - date of move abroad (i.e. no longer able to follow in any registers)</td>
<td>Health records not designed for research. LARC removals not recorded. Susceptible to human errors, e.g. typing errors. No access to health records in Espoo, i.e. lacking data on LARC initiations in Espoo. Also, no access to health records of private clinics.</td>
</tr>
<tr>
<td>Use of structural health records</td>
<td>The same EHR used in all public clinics in Vantaa. Allows for identifying LARC methods provided free of charge. Physicians receive a minor pay supplement for LARC initiation if recorded correctly.</td>
<td>Data on diagnosis if recorded correctly. Data on diagnosis might underestimate the real number of women with symptoms, as it is possible that mild symptoms are not registered in patient records.</td>
</tr>
<tr>
<td>Use of Finnish hospital discharge register</td>
<td>Reliable information on diagnosis and dates of diagnosis also for outpatient visits. Adds to the literature by allowing control for gynecological morbidity such as dysmenorrhea.</td>
<td>Data on diagnosis might underestimate the real number of women with symptoms, as it is possible that mild symptoms are not registered in patient records.</td>
</tr>
<tr>
<td>Use of Primary care register</td>
<td>Vantaa was already a pilot site in 2011, which increases accuracy of register.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>

Abbreviations: LARC: long-acting reversible contraception. EHR: Electronic health records
6.5 IMPLICATIONS AND FUTURE RESEARCH

The free-of-charge LARC program in Vantaa reached women at risk of unintended pregnancy especially well, and the program was able to provide an effective means for women to prevent unintended pregnancy. However, despite the strong association between known risk factors for unintended pregnancies, such as a history of delivery and induced abortion, and choosing to initiate a free-of-charge LARC method, many young women still at high risk of unintended pregnancy were not reached by this program. While it is encouraging that adolescents presenting with these risk factors frequently initiated LARC methods, the figures still suggest that more than half of adolescents with a history of delivery or induced abortion did not even attend a contraceptive counseling visit. There might be identifiable underlying causes and predictors for not using public services, as well as for not initiating LARC methods, despite having a need for effective contraception. Future research should focus in detail on the dimensions of contraceptive counseling from a women-centered point of view. Such studies could assess what women want from public services, and how services could be improved to better meet the needs of the population.

Women not initiating a free-of-charge LARC method presented for induced abortion more than four times as often as those initiating a free-of-charge LARC, indicating that an unmet need for family planning had been satisfied at least in part. However, this public program was implemented in a well-functioning infrastructure of public contraceptive services, and the results from this study may not be generalizable to other settings. To increase the generalizability of these results, further research is needed to control for variations in settings. One alternative would be a cluster-randomized trial where intervention sites would offer LARC methods free of charge, but as such, the resources needed would require extensive funding. More information on factors affecting the choice of contraceptive method could be obtained by a questionnaire on contraceptive knowledge, expectations, and experiences of contraception among service users. Such a survey would also bring important information on the need for counselling, a topic with considerable practical implications regarding service provision.

Both the rates of LARC initiations and induced abortions changed after the implementation of the public LARC program in Vantaa. Interestingly, compared to most studies on public funding for contraception, both the increased rate of LARC uptake and reduced rate of induced abortion were considerably larger in the present study, indicating a demand for effective contraception in the population. However, the present results originated from a single municipality implementing a free-of-charge program and might be somewhat restricted. In addition, the present program provided only LARC methods free of charge, which is probably not the most women-centered approach. Therefore, repeating the study in a large number of municipalities, both with and without free-of-charge programs, would provide further evidence.
for the effect of public programs on both LARC initiations and induced abortions. Additionally, such studies would facilitate evaluations of different types of free-of-charge programs. Cohort studies with a longer follow-up time could provide evidence on how the effect of free-of-charge programs evolves over time.

The narrow economic evaluation of direct costs implied that the program was cost-neutral among women under the age of 25. However, to draw more comprehensive conclusions on the cost-effectiveness of this type of program, formal cost analyses are needed.

### 6.5.1 POLICY CHANGES

It can be discussed whether providing economic incentives for LARC initiation is women-centered or ultimately even ethical (Foster, 2016, Foster et al., 2015, Gomez et al., 2014, Higgins et al., 2016, Rowlands and Ingham, 2017). However, in a Nordic welfare society setting with tax-funded health care, effective prevention strategies are underlined, and economically reasonable strategies are emphasized. The discrepancy between LARC method initiations (regarded as the costs) and the rate of induced abortions (the spending) stipulates for careful assessment of the free-of-charge program. Only looking at estimated effect sizes and the resource spending, the apparent solution would be to provide free-of-charge LARC methods only to women under the age of 25 years. Such inference has in part already been materialized. In 2018, short-acting methods were added to the selection of free-of-charge methods in Vantaa, available for women under 20 years old. In 2019, the free-of-charge LARC program expanded to include as many LARC methods as a woman desires until she turns 25 years old. In addition, the Finnish government program of 2019 proposes the piloting of a nationwide program providing all contraceptive methods free of charge to women under 25 years of age.

It is promising that policy makers recognize the need for removing barriers to contraception use. However, limiting free-of-charge programs to women of a certain age introduces an element of inequality. Therefore, it is important to universally provide all women, regardless of their age and other characteristics, with counseling on the variety of contraceptive methods and their efficacy.
7 CONCLUSIONS

This doctoral study evaluated the effects and characteristics of a free-of-charge LARC program in the City of Vantaa, in the Helsinki Metropolitan Area of Finland. Within this program, especially women with a history of delivery or induced abortion chose to initiate a LARC method when eligible to one free of charge, and young women with a previous abortion or childbirth particularly took up the offer. Among women initiating a free-of-charge LARC method, the need for induced abortion was significantly lower than among women eligible for a free-of-charge method, both using and not using public family planning services. Furthermore, after the start of this public program, increased LARC uptake together with a reduction in the rate of induced abortion was seen in the population.

To conclude:

1. The free-of-charge LARC program reached women with risk-factors for unintended pregnancy well.

2. Women initiating a free-of-charge LARC had an 80% lower risk of induced abortion during the two years of follow-up compared to women eligible for free-of-charge LARC and using public services, but not initiating a LARC method.

3. LARC initiation increased in all age groups.

4. Rates of induced abortion decreased among women under the age of 25.

Therefore, the results of this doctoral research suggest that the public program providing free-of-charge LARCs in Vantaa satisfied a partly unmet need for family planning in Vantaa, resulting in the increased uptake of LARC and declining rates of induced abortions.
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LONG-ACTING REVERSIBLE CONTRACEPTION FREE OF CHARGE: INITIATIONS, USER CHARACTERISTICS AND INDUCED ABORTIONS