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**Social Egg Freezing – eine ethische Reflexion (Stellungnahme Nr. 28/2017,
Bern, 11. Mai 2017)**

Büchler, Andrea ; Rost, Katja ; et al

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**National Advisory Commission on
Biomedical Ethics NCE**

Social egg freezing – ethical reflections

Opinion no. 28/2017
Bern, 11 May 2017

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I. Medical fundamentals and legal framework

1. Medical fundamentals

The term social egg freezing refers to the precautionary freezing of unfertilised egg cells (oocytes) for non-medical reasons. For women under the age of 35 who cannot currently fulfil their desire to have children, egg freezing increases the chances of achieving a pregnancy beyond the age of around 35. For reasons discussed in Section II.2, the term cryopreservation is used hereafter.

In cryopreservation, unfertilised oocytes – immediately after retrieval – are rapidly cooled to a temperature of -196°C . With this procedure, three steps need to be distinguished – the retrieval, preservation and use of oocytes. In contrast to the straightforward and non invasive procedure of sperm collection in men, a woman's oocytes need to mature prior to retrieval. This requires hormone stimulation, involving daily subcutaneous injections and possibly blood sampling, for a period of 10–14 days. The retrieval of mature oocytes is an invasive procedure, usually performed under sedation or general anaesthetic. To ensure a reasonably realistic chance of achieving pregnancy, at least 15–20 oocytes should be frozen, since not all fertilised oocytes lead to a successful pregnancy. For oocyte preservation, a new freezing technique known as vitrification is used. The survival rate for unfertilised oocytes thawed after vitrification is 80–90%. Under optimum conditions, fertilisation and implantation rates are similar with fresh and vitrified oocytes [3; 28; 29; 86; 102]; lower fertilization rates have only been reported for vitrified oocytes in a few studies [46]. This is an immense technological advance over the conventional slow-freezing method which is used, with good results, to preserve fertilised oocytes and embryos in in vitro fertilisation (IVF) treatment. When slow freezing is used to preserve unfertilised oocytes, many of the cells do not survive the freezing and thawing process, and pregnancy rates are correspondingly low; for this reason, unfertilised oocytes have only been frozen in exceptional cases in the past. Vitrified unfertilised oocytes can subsequently be used for IVF treatment (i.e. the cells are fertilised outside the woman's body). Since 2013, mature oocyte cryopreservation has no longer been considered experimental by the American Society for Reproductive Medicine [84].

The procedure does, however, involve certain medical risks. Distinctions need to be made, firstly, between those associated with the retrieval and use of oocytes and, secondly, between age- and non-age-related risks. As regards non-age-related risks associated with oocyte retrieval [123], the risk of ovarian hyperstimulation syndrome in women receiving appropriate treatment is very low (1%), thanks to new stimulation protocols. Also very rare (1 in 1000) are complications arising from the minimally invasive surgical procedure for oocyte retrieval (bleeding, infection, injury to other organs, or complications due to anaesthesia). Preliminary data on infants conceived from cryopreserved oocytes does not show any increased risk, e.g. of congenital anomalies [41]. Thus, no evidence has been found of DNA defects in vitrified oocytes or in embryos from such oocytes [46; 60; 75]. In the studies published to date [25; 75; 113], chromosome abnormalities or congenital anomalies were observed in 1.3–3.2% of cases, which is comparable to the situation in control groups. Data availability is, however, limited, as vitrification was developed and introduced relatively recently, and long-term studies are lacking.

A non-age-related risk associated with oocyte use is that of multiple pregnancy. This risk is substantially increased (15–20%) when two or more embryos are transferred; at assisted reproduction centres around the world, more than one embryo is still usually transferred to the uterus, so as to increase the chance of a pregnancy. Multiple pregnancies are more frequently associated with health problems in

the mother, such as pre-eclampsia or (emergency) Caesarean delivery. In addition, multiple pregnancies pose risks of serious (long-term) health problems in the offspring, such as prematurity, organ immaturity or brain haemorrhage. In the literature, attention is also drawn to the risk of epigenetic modifications arising from in vitro embryonic development in the first two to six days of life. Follow-up studies in children born from IVF-ICSI (in vitro fertilisation with intracytoplasmic sperm injection) show an increased incidence of cardiovascular and metabolic abnormalities, as well as cancer, obesity and autism [20; 90; 91; 94]. It is not yet known whether the risk of congenital anomalies is also increased when cryopreserved oocytes from fertile women are used, since it is unclear whether the slight increase in the rate of anomalies is attributable to as yet unidentified genetic factors in infertile couples, or whether it is a consequence of the IVF technique itself.

Of crucial importance, from a medical viewpoint, is the woman's age, both at the time when the oocytes are retrieved and when the cryopreserved oocytes are used. At the time of oocyte retrieval, the woman should if possible be under 35 years old. On average, female fertility is at its highest at the age of 25. At the age of 35–38, on average – ten years before the onset of the menopause – the quantity and quality of oocytes are already rapidly declining. Women are born with around a million immature oocytes; by the age of 30 only 12% and by the age of 40 only 3% of this ovarian reserve is left [119]. In the remaining oocytes, chromosome abnormalities are more frequent as a result of biological aging [123], so that the risk of miscarriage increases with oocyte age. In women undergoing oocyte retrieval at the age of 40, the subsequent risk of miscarriage is roughly 25–30% higher than in those aged 25 [123]. Here, it should also be pointed out that in cases where IVF treatment is indicated in women of advanced biological age, preimplantation screening could be carried out prior to embryo transfer.

In summary, it can be said that the success of oocyte cryopreservation is largely dependent on the woman's age and on the number of oocytes retrieved. Studies have shown that, in one in five women undergoing ovarian stimulation for oocyte cryopreservation, only 0–3 mature oocytes can be retrieved, owing to advanced biological age [112]. However, the age at onset of menopause varies considerably from one woman to another, with the average being 51 and a range of 40–59 years. Accordingly, a high quantity and quality of oocytes may still be retrieved from women aged over 35 [41].

As regards the woman's age at the time of oocyte retrieval, various recommendations exist: some authors recommend an upper-age limit of 38 years [117]. However, these recommendations relate to oocyte donation. The chances of success when self-donated oocytes are used may well differ from those for treatment with donor oocytes, or for spontaneous pregnancy [80; 124]. In addition, at present, women often only opt for oocyte cryopreservation at the age of 38 [73]. Not least for this reason, a quarter of IVF centres in the US, for example, accept women over the age of 40 for oocyte retrieval and cryopreservation [89], even though the pregnancy rate in this age group is very low.

Also relevant is the woman's age at the time of oocyte use, as this influences the chances of success and the course of pregnancy. Pregnancy complications are more common in older women. In a study of primiparae aged over 45, complications were observed in 84.7% of cases, including gestational hypertension (45%), gestational diabetes mellitus (42.7%), preterm delivery (33.8%), hospitalisation during pregnancy (48.1%) and Caesarean section (93.9%) [48; see also 52]. A recent large cohort study [66]

concludes that severe maternal morbidity increases significantly and exponentially with maternal age over 39, and especially over 50. Also increasing with maternal age are the risks of placenta praevia, placental abruption, perinatal mortality and fetal death [123]. Children born to older mothers are thus at increased risk for lifelong health problems such as diabetes or hypertension. Maternal mortality is also slightly increased in this age group. In addition, postnatal depression is significantly elevated with increasing maternal age [123]. Postnatal depression can impair the infant's physiological development and poses risks to the cognitive and social-emotional development and mental health of the children and adolescents concerned. In another study [52], it was shown that complications are increased in infants born to women aged over 45 at the time of delivery: prematurity was observed in almost 45 % of cases (versus 16% for control pregnancies in women aged 30), and the rate of pathologically low birthweight was twice as high.

It should, however, be noted that other pre-existing risk factors as well as age may lead to pathologies of pregnancy and birth. They include, for example, obesity [24], pre-existing cardiovascular and autoimmune diseases [105], diabetes mellitus [115], smoking (more common in low-income countries) [21] and abuse of other addictive substances. In the presence of one or more risk factors, the risks for pregnancy or birth can be estimated on the basis of existing data [105; 115]. One or more pre-existing risk factors increase the risk of neonatal and maternal morbidity and mortality. So far, however, it has not been possible, using available study results, to develop a validated risk scoring system for predicting the risk of preterm birth in individual cases [37].

Another point to be taken into account is that the chances of success with assisted reproduction at a later age are still much lower than for natural reproduction at an earlier age [65]. Computer modelling shows that out of 100 women who start trying to conceive at the age of 30, 91 will achieve a natural pregnancy within four years, 3 will have a child during the next two years thanks to assisted reproduction technology (ART), and 6 will remain childless. Out of 100 women starting at the age of 35, 82 will have a child within three years, with 4 conceiving thanks to ART and 14 remaining childless. Out of 100 women starting at the age of 40, 57 will have a child within two years, 7 will do so thanks to ART and 36 will remain childless. Thus, irrespective of age – in spite of modern reproductive medicine – more than 90% of women either conceive naturally or remain childless. At the same time, less than 7% of all women have children with the aid of ART. Specific studies of oocyte cryopreservation show that, under optimum ART conditions, the cumulative live birth rate (CLBR) in women aged 35 or younger is 15.4% with 5 oocytes, 40.8% with 8 oocytes and 85.2% with 10–15 oocytes [27]. In women aged 36 or older, the CLBR is 5.1% with 5 oocytes, 19.9% with 8 oocytes and 35.6% with 11 oocytes. Even more sobering are the figures from the national registry data of the UK Human Fertilisation and Embryology Authority (HFEA): only 1.7% of patients' oocytes thawed between 2008 and 2013 led to live births [4]. Accordingly, Leridon [65] concludes: "The message for a woman aged <35 years trying to conceive is: be patient. [...] The message for women aged ≥35 years is: be impatient. The chances of a rapid spontaneous conception are still significant, but in case of failure, ART will not fully compensate for the years (and the chances of conceiving) lost." In addition, computer simulation models show that, despite the availability of IVF, women should start trying to conceive at an early age if they wish to realise a desired family size [49]: to have a 90% chance of success in realising a one-child family, the maximum starting age for the female partner is 32 without and 35 with the option of IVF. For a 90% chance of a two-child

family, the maximum starting age is 27 without and 31 with the IVF option. For a 90% chance of a three child family, the maximum starting age is 23 without and 28 with the IVF option.

The total costs of fertility preservation (including IVF) can range from CHF 10,000 to as much as CHF 30,000 or more. This is due to the relatively expensive drugs required for ovarian stimulation, which have to be injected subcutaneously (sometimes twice daily) for 10–14 days. In addition, the oocytes have to be retrieved in an outpatient surgical procedure (under sedation or general anaesthetic) in the operating theatre; in the IVF laboratory, they are then prepared for vitrification under controlled conditions (temperature, oxygen, cleanroom conditions, etc.) and frozen. The costs per cycle are around CHF 3,000–5,000. Often, several cycles are required per patient to obtain sufficient numbers of mature oocytes. Other costs include the fees for cryostorage (at -196°C in liquid nitrogen), generally amounting to CHF 150–200 per year (i.e. approx. CHF 1,500–2,000 for 10 years), and the costs of IVF-ICSI, embryo culture and preparations for embryo transfer, amounting to CHF 2,000–2,500 per thaw cycle. Often, three treatment cycles are required to establish a pregnancy, at a total cost of at least CHF 20,000.

2. Legal framework

Since 1 January 2001, assisted reproductive measures in Switzerland have been regulated by the Reproductive Medicine Act (RMA).

From a legal perspective, oocyte cryopreservation is essentially permissible. Under Art. 15 para. 1 RMA, the preservation of reproductive cells is permitted, for five years, with the consent of the person from whom they were obtained. Under the revised RMA (Art. 15 para. 1 rev. RMA), the woman concerned may request a five-year extension of the preservation period. Under Art. 15 para. 2 RMA, by way of exception, a longer preservation period may be agreed “with persons who have their reproductive cells preserved with a view to producing their own offspring at a later date because medical treatment they undergo or an activity they carry out could lead to infertility or damage to their genetic material”. According to the current state of the debate among legal scholars, and according to the decision of an appeal court (Administrative Court St Gallen, 2013), oocyte retrieval for the purpose of preservation is not an assisted reproductive technique as defined in Art. 2 let. a RMA, particularly since it does not directly serve to establish a pregnancy; for this reason, there is no need for an indication – in particular, infertility – as specified in Art. 5 RMA [80]. Equally, the requirements for access to assisted reproduction, such as the existence of a heterosexual partnership, need not be met.

Nonetheless, oocyte cryopreservation is not supported or promoted by current legislation, for two reasons in particular: firstly, the maximum preservation period is relatively short, especially since – for reasons of oocyte quality – it is recommended that retrieval should be undertaken as early as possible. Secondly, a medical indication is required at the time the cryopreserved oocytes are used, since here the regulations for assisted reproduction are applicable. In practice, this means that the “younger” oocytes may only be used if a natural pregnancy no longer appears to be possible. Also applicable, in addition, are the general requirements for the permissibility of assisted reproductive techniques, including the requirement that the couple, on the basis of their age and personal circumstances, should be likely to be able to care for and bring up the child until it reaches the age of majority (Art. 3 para. 2 let. b RMA). Current legislation thus does not specify a precise age at which cryopreserved oocytes may be used, but regulates the maximum preservation period. In the literature, time limits imposed on the storage of gametes have been criticised on the grounds that they create incentives for women to postpone oocyte retrieval to a later age (to the detriment of oocyte quality) or to transfer oocytes to countries where regulations are less stringent [58].

In principle, cryopreserved oocytes may be transferred to an assisted reproduction centre abroad, if the woman so desires. Transfers of oocytes from other countries to Switzerland would also be conceivable, though presumably less likely on account of the restrictive regulations in this country. How often transfers of this kind occur is not known. When the preservation period has expired, the oocytes are destroyed. In Switzerland, these oocytes may not be donated, owing to the prohibition on egg donation (Art. 4 RMA).

In Switzerland, registration of the cryopreservation of unfertilised oocytes is not mandatory; thus, no reliable data is available. A registry has been established by the Fertility Preservation Commission (FertiSave) of the Swiss Society of Reproductive Medicine (SGRM). However, as entries are made on a

voluntary basis, the figures are extremely unreliable. Mandatory registries for cryopreservation are also lacking in other countries – with a few exceptions, such as the UK.

II. Motives and prevalence

1. Social background to the increase in assisted reproduction

It is estimated by the European Society of Human Reproduction and Embryology (ESHRE) that, worldwide, more than 6.5 million children have been born thanks to assisted reproductive technology. The annual increase in ART services is 5–10% in developed countries [22]. In the US, between 2006 and 2010, 12% of women aged 15–44 had received infertility services (e.g. diagnostic tests) at some point [30], and ART accounts for 1.3% of all live births [12; 16; 95]. In Denmark, 4.2% of all live births between 2002 and 2004 were attributable to ART; this relatively high proportion can partly be explained by the fact that the costs of ART are covered by the Danish health system [12]. In the US, cryopreservation of unfertilised oocytes is a widely used procedure; the creation of a fertility reserve at a fertile age now appears to be common practice among women in more affluent segments of the population. In the UK, demand for oocyte cryopreservation rose threefold between 2008 and 2013 [4]. For Switzerland, no reliable figures are available.

Underlying the increasing use of assisted reproduction – and thus also cryopreservation – are various social developments. Firstly, over the past 50 years, female participation in the labour market has increased by more than 50% in developed countries [1]. Secondly, the average age at marriage and divorce has risen [67]. Thirdly, life expectancy has risen dramatically and will continue to do so. Although most babies born in 1900 did not live past the age of 50, life expectancy at birth is now up to 81 years. The steady increase in life expectancy has averaged about three months of life per year [122]. Fourthly, the average age of women at the birth of their first child has risen [67]. Late childbearing has risen substantially in Europe since 1960 and in the US since 1970: the proportion of all births occurring to women over 40 is now about 3–4% [12], representing a two- to fourfold increase compared to the 1970s and 1980s. However, the large number of births to women over 40 is attributable not to a higher probability of conceiving among these women, but to demographic changes: as a result of declining birth rates, women aged 40–49 now make up a larger proportion of the total population of women of childbearing age [12]. Fifthly, fertility rates have fallen significantly overall [67], and the number of women remaining childless has risen. In most European countries, the average fertility rate is currently around 1.6 children per woman (the replacement-level fertility rate would be 2.1 children per woman). Women aged 40–49 now account for a much lower proportion of the total fertility rate than in the 19th century, for example [12]. Around half of all births to women aged 40–44 are first or second children; the proportion conceived after oocyte donation is not known. Thus, in contrast to the 19th century, when mothers of advanced age already had a number of children, women today are delaying motherhood ever later into their thirties or forties. Data from Sweden indicate that the probability that a childless woman aged 40 will have children has increased: while 1 in 30 did so in 1970, the proportion in 2002 was 1 in 13 [12]. However, according to the same study, pregnancy rates in childless women aged 45 have been more constant: 1 in 600 had children in 1970, and 1 in 450 did so in 2002 [12]. There are two reasons for this: (1) many women aged 45 decide to remain childless; (2) for those who do wish to have children, the probability of achieving a pregnancy with their own oocytes is very low, despite the availability of ART [12]. Even though oocyte donation is today used increasingly frequently, projections indicate that 22% of women born in 1990 or later will remain childless while 15% of mothers will have their first child at the age of 35 or over [67].

As the statistics suggest, there has been no change in the age at the onset of menopause, or the duration of the reproductive lifespan, over the period investigated. It is estimated that, in populations not using contraception, the median age at last birth is 41.2 years, while the onset of sterility is at 44.7 and menopause at 50.5 years [65]. Postponing pregnancy to a later age therefore increases the risk of childlessness: this risk is 6% when pregnancy attempts are delayed until the age of 30, 14% when attempts begin at 35, and 35% when they begin at 40 [67].

In developed countries, evidence shows that the gap between rich and poor is also becoming more pronounced in the area of fertility, partly because of increases in the earning power of well-educated women [19; 67]. It has been estimated that, in the near future, 28% of graduate women will remain childless, compared to only 17% of those with intermediate qualifications [61]. A shifting trend is also apparent among men: while today men with lower educational attainment in particular are childless, childlessness is predicted to increase among graduate men [61]. This trend reflects an ambivalent attitude towards parenthood among young people today – especially those with tertiary qualifications and good employment prospects. The limited period available for parenthood coincides with the time in which education, career and economic goals are prioritised [31; 32; 54; 59; 67; 81]. The result is frequently either a smaller family size or childlessness.

Irrespective of socioeconomic status, declining fertility rates in contemporary societies are also due to so-called cultural lag [77]: women have to decide between career and family because, in spite of female participation in employment, the traditional distribution of roles between men and women has not (yet) changed. Cultural lag leads to low fertility rates, as seen at present in East Asia or in early-20th-century Europe [2]. Cultural lag will be overcome if women attain greater bargaining power vis-à-vis men as they no longer work exclusively in low-income sectors and occupations, and institutional childcare and greater male participation in household tasks thus become possible [44]. Fertility rates in European countries where this trend is most advanced (1.96 in France, 1.88 in Sweden, 1.81 in the UK [103]) have almost returned to a fertility level of two children per woman. By contrast, in those European countries where the traditional “male breadwinner/female homemaker” model is still prevalent, fertility rates remain low (1.54 in Switzerland, 1.5 in Germany, 1.35 in Italy [103]) [9].

2. Motives for cryopreservation of unfertilised oocytes

With regard to the motives for cryopreservation of unfertilised oocytes, a distinction is often made between medical and social reasons. Fertility preservation may be indicated on medical grounds, for example in the case of a reproductive-age woman who is to undergo chemo- or radiotherapy for cancer. Such treatments are frequently highly toxic, leading to partial or complete destruction of the oocytes and thus causing sterility. Since 2010, however, fertility preservation for non-medical reasons has been (sometimes vigorously) promoted by various assisted reproduction centres. This development has given rise to the notion of social egg freezing: “Underlying this distinction can be seen a moral economy of responsibility, which makes younger women the victims of a medical condition, whom reproductive medicine has to help, whereas childless older women are seen as the only ones responsible for their situation and thus not included in the category of legitimate potential users” [17: 88]. From this viewpoint, fertility preservation for medical reasons is morally approved, while fertility preservation for non-medical reasons is morally re-

jected. In the popular media, women who resort to oocyte cryopreservation for medical reasons are thus represented as worthy of support, whereas healthy women using this method are viewed with ambivalence [68]. The latter may be perceived as naive and liable to exploitation by assisted reproduction centres [40], or as selfish and self-interested, but they may also be seen as progressive and emancipated [56].

In particular cases, however, distinguishing between social egg freezing and medically indicated fertility preservation is not so straightforward [61; 70; 79; 99]. Firstly, some women may enter the menopause very early, sometimes even at the age of 25 or 30. For example, in the case of a 20-year-old carrier of a genetic defect leading to premature ovarian failure (premature menopause) who is still fertile and wishes ultimately to have a family but does not currently have a partner, it is not clear whether fertility preservation is medically indicated or socially motivated. Moreover, it has not been possible to date to predict the onset of menopause with any degree of accuracy. Secondly, in older women who fail to conceive naturally, IVF is carried out on the basis of a “medical” indication in the presence of additional mild infertility factors (e.g. slightly reduced sperm motility). The main reason – generally postponement of pregnancy – is, however, of a societal and social nature (cf. also Sections II.3 and IV).

If women themselves are asked to explain why they opt for oocyte cryopreservation, more than half mention a gain in “reproductive time”, which also gives them more time to find a suitable partner [55; 106]. Many women also want to take away the pressure to find a partner [7; 106]. Egg banking increases their chances in the “partnership market”, partly because many men who meet childless women aged 35–45 shy away from this pressure [118]. In addition, women see this procedure as offering insurance against involuntary childlessness [36; 114]. The psychological effects of cryopreservation for the women concerned are thus not to be underestimated. Only 20% of these women explicitly cite their career as a primary motive for cryopreservation [118].

3. Use of cryopreserved unfertilised oocytes

Systematic, representative research on the demographic characteristics and life situations of women who consider or opt for cryopreservation is currently lacking [7]. A consistent finding of all studies carried out to date is that the women are on average aged 35–38, generally heterosexual, single and childless, well educated, and working in demanding, highly competitive, high-income positions, requiring high levels of flexibility, (global) mobility and time commitment [7; 8; 38; 55; 67; 118]. Accordingly, many of these women live in the urban centres of today's global economy. Professional mobility requirements often lead to the break-up of their earlier, long-term relationships between the ages of 20 and 35. New potential partners are often sought online; however, readiness to commit to long term relationships appears to be limited on online dating sites in urban centres [118].

In one study, almost 80% of the women reported that they wished they had undergone oocyte cryopreservation at an earlier age [55]. Reasons commonly given include a lack of knowledge about fertility and misleading media reports about the possibilities of late pregnancy: "But it is the same with all these celebrities. I wrote about that in my blog yesterday. They are all pregnant, in their radiant forties, this is very nice, but so hypocritical! And dangerous, in the sense that it perpetuates the idea that it is possible to have children when older. Women are then told that it is too late and that they have to turn to egg donation. But we ask what about them? They as well, probably ... (Valérie, 7 October 2011)" [17: 94]. By failing to mention the origin of oocytes (oocyte donation) and generalising from exceptional cases, the media gloss over the limited chances of natural pregnancy in women over 40. In addition, the women are often confronted with the abrupt end of a long-term relationship.

In most cases, women's knowledge of cryopreservation comes from the media and from the experiences of people in their immediate circle. Most of these women have some personal familiarity with assisted reproductive techniques such as IVF in combination with sperm or oocyte donation [118]. Women who opt for cryopreservation of unfertilised oocytes see the freezing of their own eggs as a means of realising their desire to have children and thus as a way of "living on" in future generations. The women's actions are thus guided by their individual needs for children that are genetically their own. For most of the women concerned, oocyte donation or adoption is not an acceptable alternative [118]; in addition, adoption is an obstacle-ridden procedure, which is not always available. If women realise that their biological time is running out, they are not discouraged by the low chances of success of cryopreservation or possible subsequent IVF treatment. What is crucial for them is to have tried everything to achieve genetic motherhood [118].

Most women hope to conceive naturally in spite of opting for cryopreservation [7]. As the procedure is relatively new, it is not yet known precisely how many women will actually use their cryopreserved oocytes. In a Spanish multicentre study, only 9.3% of women who had undergone elective fertility preservation between 2007 and 2015 returned to use their oocytes [27].

Oocyte cryopreservation is currently marketed to women, especially in the US, using the slogan "Let's chill" at "egg freezing parties" and seminars, or at nail and cosmetic studios [50]. It can be assumed that this trend will soon spread to Europe. Assisted reproduction centres frequently portray cryopreservation as banking or insurance against childlessness: "DID YOU KNOW ... Egg quality begins to decline

at 27 and significantly deteriorates every year past 35. But now you have options!” [68: 538].

Representative studies on attitudes to oocyte cryopreservation among women of reproductive age show that about half would not consider the procedure, while around 30% are open to the idea [7; 107]. 80% of women have already heard of cryopreservation from the media. Compared to those opposed to cryopreservation, potential users are younger, more rarely in a permanent relationship, more frequently childless and employed, and wish to have children at a later age. There are, however, no differences with regard to religion, education, sexual orientation, ethnicity or awareness of cryopreservation. Studies involving younger, highly educated women – e.g. medical students – suggest that the younger generation of women would use cryopreservation with a view to having more time for their personal projects or career development [7]; however, predictions of behaviour are difficult.

Research also shows that women’s awareness of fertility issues – including highly educated women – is frequently inadequate [107]. In a study in the US, 67% of female (and 81% of male) university students overestimated the age at which women experience a marked decrease in fertility [81]. In addition, 52% of female (and 64% of male) university students overestimated the chances of IVF being successful [81]. Similar results have been obtained in studies carried out in Sweden, Finland, Italy or Canada [15; 63; 88; 108; 116].

III. An individual ethics perspective

In what follows, an overview is given of arguments presented in the literature either supporting or opposing oocyte cryopreservation from the perspective of individual ethics. The position of the NCE is set out in Section V.

1. Retrieval and preservation of oocytes

Cryopreservation of unfertilised oocytes is an invasive medical procedure which poses certain risks both for women and for potential children. The question thus arises whether this procedure is compatible with the principle of non-maleficence.

Against compatibility with the principle of non-maleficence it is argued, firstly, that in the case of cryopreservation only a fraction of the women concerned ultimately use their cryopreserved oocytes, since most conceive naturally and some decide to remain childless. This means that, in contrast to conventional IVF, many women are exposed to the risks of hormone treatment and the invasive retrieval procedure without a child being born as a result [41; 42]. Secondly, oocyte defects increase with a woman's age, which may be relevant if oocytes are retrieved from older women [33; 72], although this argument also applies to natural conception. Thirdly, it is pointed out that long-term studies on the health of children born from cryopreserved oocytes are currently lacking [18; 78; 123]. Hence, it is argued, exercising reproductive autonomy in this way means accepting risks for a future child [51].

In support of compatibility with the principle of non-maleficence it is argued, firstly, that complications of hormone stimulation in women tend to be rare, now occurring in less than 1% of cases [11]. The risks associated with oocyte retrieval are even lower [11]. Secondly, cost-benefit assessments of cryopreservation should be undertaken by the women themselves, rather than by third parties. This of course means that the women concerned must be able to appreciate the significance of the procedure, which necessitates the provision of comprehensive information on the risks and costs involved, and on the chances of success. In addition, medical providers would need to comply with standard protocols. Thirdly, as for all medical procedures (e.g. cosmetic surgery), the question of proportionality arises. Since the medical risks of cryopreservation for women can be considered relatively low, these risks could essentially be regarded as acceptable under the principle of non-maleficence. Fourthly, as regards risks to the health of the future child, there is no evidence as yet that would suggest an increase in long-term risks for children born from cryopreserved oocytes. At the same time, it is stressed that the number of children followed up to date remains very low, and there is almost a complete lack of studies on the risk of congenital anomalies in this specific group (essentially fertile women) or on epigenetic modifications [18; 78; 123].

The principle of autonomy calls for the promotion of individuals' decision-making capacity and freedom. The creation of a fertility reserve through oocyte cryopreservation ultimately represents a further measure for controlling reproduction. Considered in isolation, it may be seen as expanding female reproductive options, e.g. by providing extra time to realise the desire to have children [80].

Against compatibility with the principle of autonomy it is argued that fertility preservation for non-medical reasons is a further offering of a consumer society in which starting a family is a lifestyle decision [80]. Why should women first enjoy life to the full without children and then all of a sudden seek to have

a child at an advanced age? Turning away from earlier decisions in this way is held to be inconsistent and inauthentic, and the postponement of pregnancy morally reprehensible [13]. Secondly, it is argued that while the various medical procedures involve interventions in the woman's body, they essentially address a societal problem – namely that of the incompatibility of young parenthood with contemporary expectations of the lives to be led by women and men. Thirdly, rather than changing the traditional distribution of male/female roles in any way, cryopreservation merely postpones parenthood. Fourthly, there are concerns that women may be confronted with certain expectations and placed under pressure – for example, the expectation that career and family goals are to be pursued not in parallel, but consecutively – especially in cases where the costs of cryopreservation are assumed by the employer. The objection is also raised that women who opt for cryopreservation are not making truly autonomous decisions: they generally do not act from a position of strength, but resort to cryopreservation – marketed as “insurance” against childlessness – out of necessity [51]. Fears have also been expressed that oocyte cryopreservation – like assisted reproductive techniques in general – does not or even cannot accord with the woman's autonomous wishes, since its utility in discourse and in practice primarily reflects traditional social-role expectations of woman as mother [43].

In support of compatibility with the principle of autonomy it is argued that people's life plans change – not just as a result of the possibility of cryopreservation, but also as a result of illness, separation and death. Seeking to discredit a group of people en bloc, without knowing the underlying individual motives for their behaviour, is regarded as unjustifiable [41]. In particular, it is emphasised that women are perfectly capable of making their own informed decisions, and it is patronising to portray them merely as victims of a social context [41].

The principle of autonomy also requires that informed consent be obtained prior to any diagnostic or therapeutic measure, and that consideration be given to the patient's wishes, goals and values. Particularly with regard to fertility preservation for non-medical reasons, women considering oocyte cryopreservation must be comprehensively informed about the medical and legal position – including the maximum storage time and the requirements for oocyte use, but also the fact that, owing to the limited number of oocytes cryopreserved, the chances of success are much lower than for spontaneous conception while fertility is maintained, and that postponing childbearing reduces the chances of becoming a parent [70]. Transparency is required as to the fact that the chances of success depend on the woman's age at the time of retrieval and of oocyte use [41]. This includes transparency concerning the costs of the entire procedure. Fertility clinics and centres have been criticised for making misleading claims and raising false hopes: “First, rather than ‘overall’ success rates, success rates should be given for the specific age of the candidate (at the time of freezing), especially when she is over 35. Hourvitz et al. (2009) report clinical pregnancy rates (for regular IVF) of 7.7%, 5.4%, 1.9% and 0% and delivery rates of 4.2%, 3.3%, 0.6% and 0% per cycle for women aged 42, 43, 44 and 45, respectively. This means that presenting a 44 year old woman with statistics from 42-year-old women – which seems like a minor age difference – gives her a fourfold overestimation of her chances to achieve a clinical pregnancy and an even greater overestimation of her chances of a live birth, which illustrates the importance of precision in this area” [71: 827].

The principle of beneficence requires health professionals to promote the patient's welfare. Assisted reproductive measures generally serve the patient's welfare, especially since female and male fertility is regarded as fundamental to personal development [41].

Against compatibility with the principle of beneficence it is argued that, firstly, most women undergoing oocyte retrieval are currently over 35, and the quantity and quality of oocytes are thus limited [51]. The woman's age at oocyte retrieval has a substantial effect on the success rates of subsequent IVF [111]. Ideally, women undergoing this procedure should be in their late twenties or very early thirties. Secondly, there are concerns that, as a result of their faith in technology, women will increasingly postpone pregnancy and thus suffer involuntary childlessness [100]. Thirdly, it is argued that the postponement of pregnancy to an advanced age is essentially a social problem, which cannot be addressed by technological means.

In support of compatibility with the principle of beneficence it is argued, firstly, that there is no evidence that cryopreservation causes long-term damage to embryos or oocytes [121], and that the earlier cryopreservation is performed, the lower the likelihood of genetic defects [53]. Secondly, it is emphasised that higher risks in older women are due to declining oocyte quality rather than to the age of the uterus [62; 92; 93]. Thirdly, it is pointed out that the actual target group is younger than the current group of users, who are generally well over 35. Education is required – also to ensure that women can realistically assess the chances of success with this technology. Fourthly, it is claimed that even low prospects of success would not invalidate use of the technology. Success rates following oocyte vitrification are primarily age-dependent, but comparable to those seen with IVF using fresh oocytes [29; 86; 102]. In addition, women are highly likely, ultimately, to conceive naturally, but pregnancy is by no means guaranteed [61]. Oocyte cryopreservation is thus a precautionary measure to which recourse may be had, for example, when a partnership is dissolved and biological reproductive time is running out. Lastly, two arguments are used to counter the concern that cryopreservation is a technological pseudo-solution for social problems: cryopreservation is unlikely to take the place of family-friendly employment conditions since women of working age will continue to have children even after cryopreservation; the need for family-friendly employment conditions will thus remain. Historical evidence shows that late motherhood is not an entirely new phenomenon, and births to women aged over 40 were common in the past. Not all of these women had previously had children: there were also many single women who – as a result of war or a scarcity of marriageable men – married late and unexpectedly bore children. In addition, it is argued that the life courses and models of women and men have changed – not as a result of cryopreservation, but owing to increasing individualisation, globalisation and changing values.

2. Use of oocytes

The principle of beneficence is also invoked in connection with the use of cryopreserved oocytes. Particularly controversial is the question of what is to be done if the woman is no longer of reproductive age: oocytes may be retrieved from a young, fertile woman so that they can be fertilised several decades later and then transferred to the uterus after the menopause.

Against compatibility with the principle of beneficence it is argued, firstly, that women and men are “buying time” and knowingly accepting risks for the mother and child [42]. Secondly, attention is drawn

to the specific risks involved: late pregnancy is associated with an increased risk of hypertension and gestational diabetes [6; 26], with low infant birthweight [87] and with an approximately 50% higher risk of stillbirth [57]. Thirdly, fears are expressed that older women are no longer able to cope with the physical and psychological stresses of motherhood, and that the generational order may be disrupted [100]. “Enough with the theatre! To love babies at this age, it is OK, but in a grandmother’s role. The mother will be in a retirement home, when her daughter will be 20. What is her future as a teenager, as a student? (Donzé 2010)”; or: “Another clinician recalls that according to the RMA [Reproductive Medicine Act], the use of ARTs is submitted to the wellbeing of the child and that parents must be able to raise the child until its majority: ‘To place a burden upon the child who never asked for anything is against nature, we are not entitled to do this’ (Cajeux 2008)” [17: 91]. Fourthly, in a metaphysical tradition of thought, the normativity of nature is invoked. Here, nature is understood not merely as a biological phenomenon, but as the true essence of humankind. Part of humankind’s essence is that its reproductive time span is limited [34]. From this, it is concluded that cryopreserved oocytes should only be used up to the natural age limit for reproduction. Fifthly, it is argued that it is ethically unacceptable to advise a woman aged 42 to undergo IVF using her own oocytes. Here, the live-birth rate per cycle is only 6.6%, compared to over 40% in women aged 30 [67; 7].

In support of compatibility with the principle of beneficence it is argued that, even at the end of biological fertility, the desire for children is an important aspect of personal development. Thus, the psychological consequences of childlessness are said to be just as serious for a woman aged 42 as, for example, in a young woman with cancer [61]. From this perspective, cryopreservation can be considered as insurance which one hopes never to have to use, since conception may occur naturally [61]¹. In the Netherlands, embryo transfer is permitted up to the age of 45, and in many US clinics the age limit is 50. In addition, advanced maternal age is not the only risk factor for a pregnancy (see also Section I 1.) – a major influence is also exerted by various other factors, such as educational level, socioeconomic status, lifestyle, bodyweight, pre-existing conditions, genetic factors or paternal age [93]. Numerous studies also show that children born to mothers over 40 frequently grow up in a more stable environment than those with younger mothers [74], and that older mothers are better able to cope with stress [104]. Lastly, human life expectancy has risen dramatically; people now live up to 31 years longer than in the 19th century [122]. In spite of later births, generational relations are therefore comparable to or even more favourable than in the 19th century.

1) For example, in the case of women with cancer, it can be assumed that about 20% will use their cryopreserved oocytes, as they can no longer conceive naturally. Of these women, 20% will have a successful outcome (partly due to the low number of oocytes frozen, advanced age and other factors). Thus 4 out of a 100 women will benefit from oocyte cryopreservation. Despite the low success rate, nobody would seek to deny women with cancer the option of cryopreservation. With social egg freezing, the success rates are similar, provided that the women concerned are not too young (e.g. under 25, in which case natural pregnancy is very likely) or too old (e.g. over 40, in which case cryopreservation success rates are very low).

IV. Assessment in terms of social ethics

The principle of justice calls for equitable distribution of healthcare and equality of treatment. In what follows, an overview is given of arguments presented in the literature either supporting or opposing oocyte cryopreservation from the perspective of social ethics. The position of the NCE is set out in Section V.

1. Reproductive gender equality

Given the increase in life expectancy, women's fertility is now lost at a relatively early age, especially since the biological boundaries have not shifted. At the same time, there have been significant shifts in the duration of education, the secondary and tertiary socialisation phases, entry into professional life and age at marriage. In contrast, the reproductive period for men is much less restricted – not only in terms of natural fertility, but also thanks to permissible medical methods such as sperm banking to preserve male reproductive capacity if it is threatened, sperm donation [42], or intracytoplasmic sperm injection (ICSI) in IVF. To this extent, oocyte cryopreservation would increase reproductive gender equality.

Critics reply that oocyte cryopreservation violates the natural order, which imposes limits on women, but not on men. Media commentary speaks of “destruction of the created order” [17], and of the “postmenopausal mother”, contradicting the natural ideal [98]. Women who put motherhood “on ice” are described as selfish and irresponsible. Summarising, Bühler writes: “However, the extension of fertility time through ARTs is associated with the production of a new category of mothers – older, perimenopausal, postmenopausal [...] Swiss newspapers express concern about late motherhood, considering it as highly problematic and even as a national problem, as expressed in the daily newspaper 24H title ‘Switzerland without answer to late pregnancies’ (Mayencourt 2012) in reaction to the case of a 66-year-old single woman who had given birth to twins” [17: 90 f.]. In addition, it is claimed that the expansion of female reproductive options is out of all proportion to the risks for mother and child, and to the vanishingly small proportion of women who ultimately benefit from the procedure [51].

Proponents point out, firstly, that the media's treatment of the issue regularly highlights extreme cases, such as that of a 62-year-old breastfeeding mother [98]. By contrast, representative studies show that in Sweden, for example, despite extensive use of assisted reproduction, the fraction of births above the age of 45 among all births to women aged over 40 has declined substantially since the early 20th century and it has not increased markedly since the 1980s [12]. Secondly, it is pointed out that prejudices against older mothers existed even before the era of assisted reproduction. For example, the proportion of births to mothers over 40 in the period before the Second World War was much higher than it is today – partly because no methods of contraception were available at that time, but also because of demographic changes. Older mothers were then accused of irresponsibility or a lack of continence or virtue. Thirdly, the fact that women's fertility is more restricted by biological factors than that of men is considered to be not particularly relevant to the question of the justification of cryopreservation [42]. After all, many medical procedures interfere with the course of nature, such as cosmetic surgery, sterilisation, IVF or sperm donation. Male reproductive capacity [39] benefits considerably from such procedures: intracytoplasmic sperm injection (ICSI) is used in about a third of all IVF cycles in Denmark and in 56% in the US [45; 76]; in Switzerland, the proportion is 83% [97]. It is also argued that medical and social factors cannot be wholly separated: many IVF procedures are carried out on account of infertility – a medical reason – which in turn is partly due to social factors, such as the couple's advanced

age. A holistic conception of health will also recognise, it is argued, that physiological and psychological aspects are closely interconnected. At any rate, the diagnosis of age-related infertility has psychological consequences for women. Fourthly, the postponement of family building as a result of other goals is not a new phenomenon, and it is practised not just by women but also by men. Individuals should be allowed to decide how to lead their own lives. Finally, critics of oocyte cryopreservation are said to focus exclusively on “deliberate” postponement of pregnancy. There are, however, many women who wish to make use of the procedure because they lack a suitable partner at the relevant time to start a family, or would otherwise, with a certain likelihood, be dependent on donor oocytes [41].

2. Equal treatment in reproductive medicine

Critics of oocyte cryopreservation maintain that sufficient options are already available for becoming a parent at an advanced age – for example, oocyte donation or adoption. Proponents reply that women and men evidently have a need to start a family using their own reproductive cells. For example, couples opt for ICSI – a complicated and costly procedure – and only rarely for donor sperm. So it is not clear why other criteria should be applicable for the use of female reproductive cells [41]. In this context, it is also argued that it is difficult to see why cryopreservation should be prohibited for women of fertile age, while IVF is permitted for “medical” reasons in women with age-related infertility [41].

3. Gender equality in labour markets and in relationships

In contemporary winner-take-all societies, fundamental requirements for careers are not just an excellent education but also a succession of internships, time spent abroad, long hours at work, and the willingness to travel and relocate [19]. US female top executives have the longest working hours of any women worldwide [18]. Proponents of oocyte cryopreservation argue that the time gained thereby should benefit women’s career development or strengthen their position, thus contributing to greater gender equality in labour markets [5].

Critics caution, firstly, that cryopreservation is merely a pseudo-medical solution for a social problem, and that employers need to enable or facilitate the compatibility of family and paid work. In addition, cryopreservation is not an appropriate means of increasing the number of women in employment who become mothers – on the contrary, there is a risk that the mere availability of the method could increase the pressure on women to prioritise paid work. Understanding for mothers in the workplace could be further reduced [80; 82]. Pressure to use cryopreservation could also be exerted by partners [7; 83]. In summary, doubts are expressed that women’s decisions to use oocyte cryopreservation are or can be autonomous [100]. They are usually a result of social pressures – either because the woman lacks a long-term partner and cryopreservation is marketed as insurance against childlessness, safe for mother and child, or because the economic interests of third parties are foisted upon her [51].

In reply, it is argued that a restrictive approach to cryopreservation is not helpful for women, especially since social changes take time [7]. In addition, the issue of the compatibility of child-rearing and paid work is said to be just one of many reasons why women and men delay parenthood. Others are the general increase in life expectancy, later committed relationships (e.g. marriage), new forms of partnership and individualistic tendencies [7]. In addition, it seems paternalistic to deny women the opportunity for autonomous decision making.

4. Social equality in reproduction

Today, access to assisted reproduction already depends on socioeconomic status: in the US, only 30% of low-income women with fertility problems use infertility services, compared to 50% of high-income women [23] – even though fertility problems tend to be more serious in women with a lower educational level [59]. There are fears that such disparities may be reinforced by oocyte cryopreservation [19]. Cryopreservation is costly and thus only available to a certain social class [51]. In addition, for those with a high income, the opportunity costs of reduced occupational activity are greater, and workplaces are usually more family-friendly, than in the low-income segment. Delaying parenthood thus pays off for highly educated, high-income women.

Investing in career development has its price: many highly educated individuals do not form permanent relationships [109]; this is particularly true of women [35]. Because education and career are initially prioritised, limited time remains for women in the first half of their third decade to find a suitable partner to start a family with. While highly educated women delay parenthood until they have a secure, family-friendly position, working conditions for women with a lower educational level remain unfavourable irrespective of age [18]. The labour market disadvantages suffered by highly educated women with children are frequently negligible, while they are significant for women with lower educational attainment [14]. There have also been changes in marriage markets, with high-earning men increasingly entering into partnerships with high-earning women [96]. Family incomes of high earners have thus risen considerably [18]. In addition, divorce rates have fallen among the highly educated, in contrast to those with a lower educational level [47; 69], which naturally affects the situation of the children concerned [64; 85].

These trends have prompted the criticism that the promise of oocyte cryopreservation as a means of reducing gender inequality in labour markets only applies to a certain social class [18]. Cryopreservation is said to be already a “privilege” of high-income population segments [59]. It could further increase the fertility gap between elite and low-income groups [110]. Concerns have also been expressed that cryopreservation could become routine among those who can afford it [18]. Rather than conceiving naturally, more affluent classes could use their younger (genetically lower-risk) oocytes. Lastly, the procedure is associated with a two-tier healthcare system, especially since the costs have to be borne by the individual.

5. Cryopreservation as a fringe benefit

The provision of oocyte cryopreservation as a fringe benefit – introduced, for example, by Facebook and Apple in 2014 – is a highly contentious issue [70].

Supporters of such benefits argue, firstly, that because employers consume young women’s valuable reproductive time, it is only fair that they should pay for cryopreservation. Secondly, if the costs are covered, women can be expected to opt for cryopreservation at an early age, thus increasing the chances of success if the oocytes are subsequently used.

Critics of employers’ practice of offering to cover the costs of cryopreservation mainly focus on the message thereby conveyed: raising children is not compatible with having a career [10]. It is also ar-

gued that companies are evading their responsibility to provide family friendly employment conditions. Thirdly, there is the risk of pressure: “It is one thing for individual, healthy, young women to pursue oocyte cryopreservation for personal reasons [...]. It is quite another thing for an employer to promote oocyte cryopreservation among its healthy female employees, as a result of which employees may feel pressured to postpone pregnancy and childbirth” [10: 65]. The offer of company-sponsored cryopreservation shows how personal motives and social pressures are interwoven. Of course, “delayed motherhood” also occurs during working life. It is pointed out that, in contrast to the advantages for companies, the procedure involves potential harms, with low chances of success, for the women concerned. Lastly, such agreements are scarcely operationalisable. [10].

V. Summary and recommendations

The desire to have children of one's own has both individual and anthropological (general human) origins; the desire is universal and integral to a society based on social relations. Oocyte cryopreservation is a reflection of contemporary technological efforts to guarantee the fulfilment of this desire.

The review of the arguments supporting and opposing this procedure clearly shows the contentious nature of the international debate concerning the acceptability of cryopreservation of unfertilised oocytes and their use in establishing pregnancies. This is largely due to differing assessments of the opportunities, risks and dangers associated with the new technologies.

On the one hand, cryopreservation can rightly be seen as expanding reproductive options: it makes it possible for women, even at an advanced age, to conceive and bear children, using their own oocytes and IVF. On the other hand, not only does the procedure involve health risks for woman and child, but decisions on the use of these technologies are taken in a specific social and economic context. The NCE believes that both aspects need to be taken into account in the ethical evaluation of oocyte cryopreservation. The new options are not solely conducive to autonomy – they also give rise to pressures, expectations and social exclusion. For the NCE, therefore, the fundamental and essential requirement is that women must first be empowered to make genuinely informed and autonomous reproductive choices. This also includes a social environment which supports the compatibility of motherhood, career prospects and financial independence, so that women do not defer parenthood to late middle age and thus only rarely need to resort to assisted reproduction.

In spite of its ambivalent assessment of the new technique, the NCE has formulated a number of recommendations. In line with the differences in the management and assessment of cryopreservation on the one hand and subsequent use of unfertilised oocytes on the other, the first two recommendations concern the technique of cryopreservation as such, and the next three concern subsequent use; the two final recommendations relate to general aspects, i.e. the need to create a more sound evidence base and appropriate consideration of the broader social framework.

1. Oocyte cryopreservation: eligibility and restrictions

(a) In certain cases, it may be difficult to distinguish between medical and social indications for oocyte cryopreservation – for example, in the case of a 22-year-old woman with endometriosis (a condition which, with increasing severity, can lead to infertility), whose ovarian reserve is not currently diminished, but who does not have a partner. It is not always appropriate to distinguish between a medical and a social indication.

(b) Cryopreservation is not a therapeutic measure. As a preventive measure with a medical indication (e.g. prior to cytotoxic cancer therapy), the costs of cryopreservation should be covered according to the solidarity principle.

(c) Women should have access to oocyte cryopreservation regardless of their partnership status.

(d) It is not appropriate to specify a maximum age for oocyte retrieval since there are marked individual differences with regard to ovarian reserve and chances of fertility – just as the age at onset of meno-

pause varies widely. Biological limits are of course to be taken into account, especially as increased biological age is associated with reduced oocyte quantity and quality. Information must be provided on this topic; the costs and potential risks must be weighed up against the potential benefits together with the woman concerned. For oocyte cryopreservation, the woman should have reached the age of majority.

2. Information to be provided prior to oocyte retrieval for cryopreservation

Oocyte retrieval is an invasive procedure. In connection with oocyte cryopreservation, provision of information in a comprehensive and professional manner is of the greatest importance. It is the key requirement for an autonomous decision.

(a) It must be ensured that women interested in oocyte cryopreservation are fully informed about the age-related – generally limited – chances of success of the procedure, the associated risks and costs, the legal restrictions (e.g. concerning the storage period and age at time of use), other requirements for subsequent use of cryopreserved oocytes, and alternatives to cryopreservation (including the chances of success). This information is to be provided by health professionals. Counselling on the challenges of late parenthood is also advisable.

(b) Both the woman's personal situation and the legal situation may change. It must be ensured that both the professionals and the woman concerned are informed about significant changes in the medical and legal framework, especially since the contractual relationship covers the entire period of cryopreservation.

(c) The NCE encourages health and educational institutions such as the Federal Office of Public Health, professional associations or education committees, by means of targeted information efforts, to help to improve women's and men's awareness of the development of fertility, so as to prevent involuntary childlessness and the need to resort to assisted reproductive measures.

3. Time limit for storage of cryopreserved oocytes

The Reproductive Medicine Act specifies a maximum period (i.e. 10 years) for the cryopreservation of reproductive cells. This limit should be abolished. It creates perverse incentives for young women interested in cryopreservation, insofar as they may possibly avoid preserving oocytes at an early age, even though this would be advisable, or subsequently have to transfer the oocytes to another country. There is currently no evidence to suggest that oocyte quality declines with increasing storage time.

4. Age limit for use of cryopreserved oocytes

If oocytes are cryopreserved, pregnancy may be established even at an advanced age. The question up to what age women should be allowed to use their oocytes is a matter of intense international debate. Late pregnancy involves particular risks for the mother and fetus, and late motherhood poses social and familial challenges. Under current legislation, with regard to age, couples using assisted reproductive techniques are required to be likely to be able to care for the child until it reaches the age of majority. In women, the menopause additionally represents a natural limit, which may however in individual cases be overcome by the use of younger, cryopreserved oocytes.

The question of a fixed age limit on grounds of social ethics is one which is to be answered – if at all – by democratically legitimated legislators. From an international viewpoint, the maximum age currently specified for women using cryopreserved oocytes lies between 45 and 50 years. With regard to the social dimension of parenthood – i.e. the question of the ability to care for a child, the assumption of responsibility and generational relations – motherhood and fatherhood are to be treated equally.

With regard to the medical risks associated with pregnancy at an advanced age, guidelines should be prepared by the specialist societies. Age is just one of several possible risk factors for the woman and the future child which have to be taken into account. Guidelines developed by the specialist societies (risk assessment, contraindications to pregnancy, avoidance of multiple pregnancies, etc.) are of great importance. Physicians must always refuse to provide treatment if the health risks – especially for the fetus – are too high.

5. Use of surplus oocytes

Only in a small minority of cases do women have to, or wish to, use the cryopreserved oocytes. Those which are not required are “surplus” oocytes. In Switzerland, oocyte donation is currently prohibited by law. Efforts are, however, underway to lift the ban on oocyte donation. The woman concerned should be able to express her wishes concerning the use of her surplus oocytes and choose between the possible options – i.e. to destroy them, to make them available for research, or possibly, in future, to donate them.

6. Best practice

Scientific knowledge of oocyte cryopreservation is currently based on non-representative samples, as registration is not legally required. The NCE calls for the establishment of a national registry for mandatory registration of the cryopreservation of unfertilised oocytes – similar to the mandatory registration of all IVF cycles – to permit scientific research on oocyte use and long-term effects. The registry should have a user-friendly design so as to minimise the administrative effort involved for physicians.

7. Social policy framework

Demand for oocyte cryopreservation is substantially determined by the continued difficulty of combining career and family. An additional factor are changing conceptions of the family and of the roles of women and men in society. Oocyte cryopreservation does not resolve the challenges thus raised. The onus is on society, government and business to develop solutions whereby demand for this procedure directly or indirectly attributable to social pressures and constraints can be limited.

VI. References

- 1 **Adsera, A.** 2004. Changing Fertility Rates in Developed Countries. The Impact of Labor Market Institutions. *Journal of Population Economics* 17(1) 17-43.
- 2 **Anderson, T., H.-P. Kohler.** 2013. Education Fever and the East Asian Fertility Puzzle: A Case Study of Low Fertility in South Korea. *Asian Population Studies* 9(2) 196-215.
- 3 **Antinori, M., E. Licata, G. Dani, F. Cerusico, C. Versaci, S. Antinori.** 2007. Cryotop Vitrification of Human Oocytes Results in High Survival Rate and Healthy Deliveries. *Reproductive Biomedicine Online* 14(1) 72-79.
- 4 **Arie, S.** 2015. Is Too Much Hope Placed in Egg Freezing? *British Medical Journal (Online)* 351:h5955
- 5 **Bailey, R.** 2005. *Liberation Biology: The Scientific and Moral Case for the Biotech Revolution.* Prometheus Books.
- 6 **Balash, J., E. Gratacós.** 2012. Delayed Childbearing: Effects on Fertility and the Outcome of Pregnancy. *Current Opinion in Obstetrics and Gynecology* 24(3) 187-193.
- 7 **Baldwin, K., L. Culley, N. Hudson, H. Mitchell.** 2014. Reproductive Technology and the Life Course: Current Debates and Research in Social Egg Freezing. *Human Fertility* 17(3) 170-179.
- 8 **Baldwin, K., L. Culley, N. Hudson, H. Mitchell, S. Lavery.** 2015. Oocyte Cryopreservation for Social Reasons: Demographic Profile and Disposal Intentions of UK Users. *Reproductive Biomedicine Online* 31(2) 239-245.
- 9 **Banyan.** 2016. Asia's New Family Values: Europe Shows How Asia's Demographic Crisis Might Correct Itself. *Economist.*
- 10 **Baylis, F.** 2015. Left out in the Cold: Arguments against Non-Medical Oocyte Cryopreservation. *Journal of Obstetrics and Gynaecology Canada* 37(1) 64-67.
- 11 **Bernstein, S., C. Wiesemann.** 2014. Should Postponing Motherhood Via "Social Freezing" Be Legally Banned? An Ethical Analysis. *Laws* 3(2) 282-300.
- 12 **Billari, F.C., H.-P. Kohler, G. Andersson, H. Lundström.** 2007. Approaching the Limit: Long-Term Trends in Late and Very Late Fertility. *Population and Development Review* 33(1) 149-170.
- 13 **Bittner, U., O. Müller.** 2009. Technisierung der Lebensführung. Zur ethischen Legitimität des Einfrierens von Eizellen bei gesunden Frauen als Instrument der Familienplanung. *Jahrbuch für Wissenschaft und Ethik* 14(1) 23-45.
- 14 **Boushey, H.** 2005. Are Women Opting Out? Debunking the Myth. *Center for Economic and Policy Research, Briefing Paper.*

- 15 **Bretherick, K.L., N. Fairbrother, L. Avila, S.H. Harbord, W.P. Robinson.** 2010. Fertility and Aging: Do Reproductive-Aged Canadian Women Know What They Need to Know? *Fertility and Sterility* 93(7) 2162-2168.
- 16 **Brezina, P.R., Y. Zhao.** 2012. The Ethical, Legal, and Social Issues Impacted by Modern Assisted Reproductive Technologies. *Obstetrics and Gynecology International* 2012 1-7.
- 17 **Bühler, N.** 2015. Imagining the Future of Motherhood: The Medically Assisted Extension of Fertility and the Production of Genealogical Continuity. *Sociologus* 65(1) 79-100.
- 18 **Cahn, N., J. Carbone.** 2010. *Red Families V. Blue Families: Legal Polarization and the Creation of Culture*. Oxford University Press.
- 19 **Cahn, N.R., J. Carbone.** 2013. The Gender/Class Divide: Reproduction, Privilege, and the Workplace. *GWU Legal Studies Research Paper* No. 2013-93; *GWU Law School Public Law Research Paper* No. 2013-93.
- 20 **Ceelen, M., M.M. van Weissenbruch, J.P. Vermeiden, F.E. van Leeuwen, H.A. Delemarre-van de Waal.** 2008. Cardiometabolic Differences in Children Born after in Vitro Fertilization: Follow-up Study. *The Journal of Clinical Endocrinology & Metabolism* 93(5) 1682-1688.
- 21 **Chamberlain, C., A. O'Mara-Eves, S. Oliver, J.R. Caird, S.M. Perlen, S.J. Eades, J. Thomas.** 2013. Psychosocial Interventions for Supporting Women to Stop Smoking in Pregnancy. *Cochrane Database of Systematic Reviews* 10.
- 22 **Chambers, G.M., E.A. Sullivan, O. Ishihara, M.G. Chapman, G.D. Adamson.** 2009. The Economic Impact of Assisted Reproductive Technology: A Review of Selected Developed Countries. *Fertility and Sterility* 91(6) 2281-2294.
- 23 **Chandra, A., E.H. Stephen.** 2010. Infertility Service Use among US Women: 1995 and 2002. *Fertility and Sterility* 93(3) 725-736.
- 24 **Chandrasekaran, S., G. Neal-Perry.** 2017. Long-Term Consequences of Obesity on Female Fertility and the Health of the Offspring. *Current Opinion in Obstetrics and Gynecology* 29(3) 180-187.
- 25 **Chian, R.-C., J.Y. Huang, S.L. Tan, E. Lucena, A. Saa, A. Rojas, L.A.R. Castellón, M.I.G. Amador, J.E.M. Sarmiento.** 2008. Obstetric and Perinatal Outcome in 200 Infants Conceived from Vitrified Oocytes. *Reproductive Biomedicine Online* 16(5) 608-610.
- 26 **Cleary-Goldman, J., F.D. Malone, J. Vidaver, R.H. Ball, D.A. Nyberg, C.H. Comstock, G.R. Saade, K.A. Eddleman, S. Klugman, L. Dugoff.** 2005. Impact of Maternal Age on Obstetric Outcome. *Obstetrics & Gynecology* 105(5, Part 1) 983-990.

- 27 **Cobo, A., J.A. García-Velasco, A. Coello, J. Domingo, A. Pellicer, J. Remohí.** 2016. Oocyte Vitrification as an Efficient Option for Elective Fertility Preservation. *Fertility and Sterility* 105(3) 755-764. e758.
- 28 **Cobo, A., M. Kuwayama, S. Pérez, A. Ruiz, A. Pellicer, J. Remohí.** 2008. Comparison of Concomitant Outcome Achieved with Fresh and Cryopreserved Donor Oocytes Vitrified by the Cryotop Method. *Fertility and Sterility* 89(6) 1657-1664.
- 29 **Cobo, A., M. Mesequer, J. Remohí, A. Pellicer.** 2010. Use of Cryo-Banked Oocytes in an Ovum Donation Programme: A Prospective, Randomized, Controlled, Clinical Trial. *Human Reproduction* 25(9) 2239-2246.
- 30 **Centers for Disease Control and Prevention, American Society for Reproductive Medicine, Society for Assisted Reproductive Technology.** 2014. 2012 Assisted Reproductive Technology. *Fertility Clinic Success Rates Report*. Atlanta (GA): US Dept of Health and Human Services.
- 31 **Cooke, A., T.A. Mills, T. Lavender.** 2010. "Informed and Uninformed Decision Making" – Women's Reasoning, Experiences and Perceptions with Regard to Advanced Maternal Age and Delayed Childbearing: A Meta-Synthesis. *International Journal of Nursing Studies* 47(10) 1317-1329.
- 32 **Cooke, A., T.A. Mills, T. Lavender.** 2012. Advanced Maternal Age: Delayed Childbearing Is Rarely a Conscious Choice: A Qualitative Study of Women's Views and Experiences. *International Journal of Nursing Studies* 49(1) 30-39.
- 33 **Coticchio, G., J. Bromfield, R. Sciajno, A. Gambardella, G. Scaravelli, A. Borini, D. Albertini.** 2009. Vitrification May Increase the Rate of Chromosome Misalignment in the Metaphase II Spindle of Human Mature Oocytes. *Reproductive Biomedicine Online* 19 29-34.
- 34 **Cottier, G.** 2016. Nature et Nature Humaine. *Nova et Vetera* 91(3) 297-315.
- 35 **Daniels, K., R. Raley.** 2010. Educational Attainment, Romantic Relationships, and Non-Marital Fertility. *Annual Meeting of the Population Association of America, Dallas, TX*.
- 36 **Daniluk, J.C.** 2001. "If We Had It to Do over Again...": Couples' Reflections on Their Experiences of Infertility Treatments. *The Family Journal* 9(2) 122-133.
- 37 **Davey, M.-A., L. Watson, J.A. Rayner, S. Rowlands.** 2011. Risk Scoring Systems for Predicting Preterm Birth with the Aim of Reducing Associated Adverse Outcomes. *Cochrane Database Syst Rev* 11(1).
- 38 **De Groot, M., E. Dancet, S. Repping, D. Stoop, M. Goddijn, F. Van der Veen, T. Gerrits.** 2013. The Voice of Dutch Women with Anticipated Gamete Exhaustion Who Consider Oocyte Freezing to Increase Their Chances on Shared Parenthood. *European Society of Human Reproduction and Embryology*, London: ExCel Centre.

- 39 **De La Rochebrochard, E., P. Thonneau.** 2005. Paternal Age: Are the Risks of Infecundity and Miscarriage Higher When the Man Is Aged 40 Years or Over? *Revue d'épidémiologie et de santé publique* 53 47-55.
- 40 **de Melo-Martin, I., I.N. Cholst.** 2008. Researching Human Oocyte Cryopreservation: Ethical Issues. *Fertility and Sterility* 89(3) 523-528.
- 41 **Dondorp, W., G. de Wert, G. Pennings, F. Shenfield, P. Devroey, B. Tarlatzis, P. Barri, K. Die-drich, E.T.F.o. Ethics, Law.** 2012. Oocyte Cryopreservation for Age-Related Fertility Loss. *Human Reproduction* 27(5) 1231-1237.
- 42 **Dondorp, W.J., G.M. De Wert.** 2009. Fertility Preservation for Healthy Women: Ethical Aspects. *Human Reproduction* 24(8) 1779-1785.
- 43 **Eagly, A.H.** 2013. *Sex Differences in Social Behavior: A Social-Role Interpretation*. Psychology Press.
- 44 **Esping-Andersen, G.** 2009. *Incomplete Revolution: Adapting Welfare States to Women's New Roles*. Polity.
- 45 **Ferraretti, A.P., V. Goossens, M. Kupka, S. Bhattacharya, J. de Mouzon, J.A. Castilla, K. Erb, V. Korsak, A.N. Andersen, H. Strohmer.** 2013. Assisted Reproductive Technology in Europe, 2009: Results Generated from European Registers by Eshre. *Human Reproduction* 28(9) 2318-2331.
- 46 **Forman, E.J., X. Li, K.M. Ferry, K. Scott, N.R. Treff, R.T. Scott.** 2012. Oocyte Vitrification Does Not Increase the Risk of Embryonic Aneuploidy or Diminish the Implantation Potential of Blastocysts Created after Intracytoplasmic Sperm Injection: A Novel, Paired Randomized Controlled Trial Using DNA Fingerprinting. *Fertility and Sterility* 98(3) 644-649.
- 47 **Furstenberg, F.F.** 2012. Charles Murray, Coming Apart: The State of White America 1960–2010. *Population and Development Review* 38(3) 551-554.
- 48 **Glasser, S., A. Segev-Zahav, P. Fortinsky, D. Gedal-Beer, E. Schiff, L. Lerner-Geva.** 2011. Primiparity at Very Advanced Maternal Age (≥ 45 Years). *Fertility and Sterility* 95(8) 2548-2551.
- 49 **Habbema, J.D.F., M.J. Eijkemans, H. Leridon, E.R. te Velde.** 2015. Realizing a Desired Family Size: When Should Couples Start? *Human Reproduction* 30(9) 2215–2221.
- 50 **Haker, H.** 2016. Kryokonservierung Von Eizellen – Neue Optionen der Familienplanung? Eine ethische Bewertung. *Zeitschrift für medizinische Ethik* 62 121-132.
- 51 **Harwood, K.** 2009. Egg Freezing: A Breakthrough for Reproductive Autonomy? *Bioethics* 23(1) 39-46.

- 52 **Haslinger, C., B. Stoiber, F. Capanna, M.-K. Schäffer, R. Zimmermann, L. Schäffer.** 2016. Postponed Pregnancies and Risks of Very Advanced Maternal Age. *Swiss Medical Weekly* 146 1-6.
- 53 **Hassold, T., P. Hunt.** 2009. Maternal Age and Chromosomally Abnormal Pregnancies: What We Know and What We Wish We Knew. *Current Opinion in Pediatrics* 21(6) 703.
- 54 **Heck, K.E., K.C. Schoendorf, S.J. Ventura, J.L. Kiely.** 1997. Delayed Childbearing by Education Level in the United States, 1969–1994. *Maternal and Child Health Journal* 1(2) 81-88.
- 55 **Hodes-Wertz, B., S. Druckenmiller, M. Smith, N. Noyes.** 2013. What Do Reproductive-Age Women Who Undergo Oocyte Cryopreservation Think About the Process as a Means to Preserve Fertility? *Fertility and Sterility* 100(5) 1343–1349.
- 56 **Homburg, R., F. van der Veen, S.J. Silber.** 2009. Oocyte Vitrification—Women’s Emancipation Set in Stone. *Fertility and Sterility* 91(4) 1319-1320.
- 57 **Huang, L., R. Sauve, N. Birkett, D. Fergusson, C. van Walraven.** 2008. Maternal Age and Risk of Stillbirth: A Systematic Review. *Canadian Medical Association Journal* 178(2) 165-172.
- 58 **Jackson, E.** 2016. “Social” egg Freezing and the UK’s Statutory Storage Time Limits. *Journal of Medical Ethics* 42(11) 738-741.
- 59 **Jain, T.** 2006. Socioeconomic and Racial Disparities among Infertility Patients Seeking Care. *Fertility and Sterility* 85(4) 876-881.
- 60 **Khalili, M.A., M. Maione, M.G. Palmerini, S. Bianchi, G. Macchiarelli, S.A. Nottola.** 2012. Ultrastructure of Human Mature Oocytes after Vitrification. *European Journal of Histochemistry* 56(3) 38.
- 61 **Kneale, D., H. Joshi.** 2010. Postponement and Childlessness: Evidence from Two British Cohorts. *Demographic Research* 19 1935-1968.
- 62 **Kort, D.H., J. Gosselin, J.M. Choi, M.H. Thornton, J. Cleary-Goldman, M.V. Sauer.** 2012. Pregnancy after Age 50: Defining Risks for Mother and Child. *American Journal of Perinatology* 29(4) 245-250.
- 63 **Lampic, C., A.S. Svanberg, P. Karlström, T. Tydén.** 2006. Fertility Awareness, Intentions Concerning Childbearing, and Attitudes Towards Parenthood among Female and Male Academics. *Human Reproduction* 21(2) 558-564.
- 64 **Lareau, A.** 2011. *Unequal Childhoods: Class, Race, and Family Life*. University of California Press.
- 65 **Leridon, H.** 2004. Can Assisted Reproduction Technology Compensate for the Natural Decline in Fertility with Age? A Model Assessment. *Human Reproduction* 19(7) 1548-1553.

- 66 **Lisonkova, S., J. Potts, G.M. Muraca, N. Razaz, Y. Sabr, W.-S. Chan, M.S. Kramer.** 2017. Maternal Age and Severe Maternal Morbidity: A Population-Based Retrospective Cohort Study. *PLOS Medicine* 14(5) e1002307.
- 67 **Lockwood, G.M.** 2011. Social Egg Freezing: The Prospect of Reproductive "Immortality" or a Dangerous Delusion? *Reproductive Biomedicine Online* 23(3) 334-340.
- 68 **Martin, L.J.** 2010. Anticipating Infertility: Egg Freezing, Genetic Preservation, and Risk. *Gender & Society* 24(4) 526-545.
- 69 **McLanahan, S.** 2004. Diverging Destinies: How Children Are Faring under the Second Demographic Transition. *Demography* 41(4) 607-627.
- 70 **Mertes, H.** 2015. Does Company-Sponsored Egg Freezing Promote or Confine Women's Reproductive Autonomy? *Journal of Assisted Reproduction and Genetics* 32(8) 1205-1209.
- 71 **Mertes, H., G. Pennings.** 2011. Social Egg Freezing: For Better, Not for Worse. *Reproductive Biomedicine Online* 23(7) 824-829.
- 72 **Nawroth, F., R. Dittrich, M. Kupka, B. Lawrenz, M. Montag, M. von Wolff.** 2012. Kryokonservierung von unbefruchteten Eizellen bei nichtmedizinischen Indikationen ("Social Freezing"). *Frauenarzt* 53 528-533.
- 73 **Nekkebroeck, J., D. Stoop, P. Devroey.** 2010. A Preliminary Profile of Women Opting for Oocyte Cryopreservation for Non-Medical Reasons. *Human Reproduction* 25(1) 14-17.
- 74 **Nilsen, A.B.V., U. Waldenström, A. Hjelmsted, S. Rasmussen, E. Schytt.** 2012. Characteristics of Women Who Are Pregnant with Their First Baby at an Advanced Age. *Acta Obstetrica et Gynecologica Scandinavica* 91(3) 353-362x.
- 75 **Noyes, N., E. Porcu, A. Borini.** 2009. Over 900 Oocyte Cryopreservation Babies Born with No Apparent Increase in Congenital Anomalies. *Reproductive Biomedicine Online* 18(6) 769-776.
- 76 **Nyboe Andersen, A., K. Erb.** 2006. Register Data on Assisted Reproductive Technology (Art) in Europe Including a Detailed Description of Art in Denmark. *International Journal of Andrology* 29(1) 12-16.
- 77 **Ogburn, W., F.** 1957. Cultural Lag as Theory. *Sociology & Social Research* 41(3) 167-174.
- 78 **OOCYTE, M.** 2013. Mature Oocyte Cryopreservation: A Guideline. *Fertility and Sterility* 99(1).
- 79 **Pennings, G.** 2013. Ethical Aspects of Social Freezing. *Gynécologie Obstétrique & Fertilité* 41(9) 521-523.

- 80 **Peter, C.** 2015. Rechtliche, ethische und gleichstellungspolitische Aspekte des Social Freezing. *Journal of Law, Medicine & Ethics* 10(8) 1-12.
- 81 **Peterson, B.D., M. Pirritano, L. Tucker, C. Lampic.** 2012. Fertility Awareness and Parenting Attitudes among American Male and Female Undergraduate University Students. *Human Reproduction* 27(5) 1375-1382.
- 82 **Petropanagos, A.** 2010. Reproductive "Choice" and Egg Freezing. *Oncofertility*. Springer, 223-235.
- 83 **Petropanagos, A.** 2013. *Fertility Preservation Technologies for Women: A Feminist Ethical Analysis*. University of Western Ontario.
- 84 **Practice Committee of the American Society for Reproductive Medicine** 2013. Fertility Preservation in Patients Undergoing Gonadotoxic Therapy or Gonadectomy: A Committee Opinion. *Fertility and Sterility* 100(5) 1214-1223.
- 85 **Reardon, S.F.** 2011. The Widening Academic Achievement Gap between the Rich and the Poor: New Evidence and Possible Explanations (91-116). In R. Murnane & G. Duncan (Eds.), *Whither Opportunity? Rising Inequality and the Uncertain Life Chances of Low-Income Children*. New York: Russell Sage Foundation Press.
- 86 **Rienzi, L., S. Romano, L. Albricci, R. Maggiulli, A. Capalbo, E. Baroni, S. Colamaria, F. Sapienza, F. Ubaldi.** 2010. Embryo Development of Fresh "Versus" Vitrified Metaphase II Oocytes after ICSI: A Prospective Randomized Sibling-Oocyte Study. *Human Reproduction* 25(1) 66-73.
- 87 **Ritzinger, P., J.W. Dudenhausen, W. Holzgreve.** 2011. Späte Mutterschaft und deren Risiken. *Journal für Reproduktionsmedizin und Endokrinologie* 8(2) 112-122.
- 88 **Rovei, V., G. Gennarelli, T. Lantieri, S. Casano, A. Revelli, M. Massobrio.** 2010. Family Planning, Fertility Awareness and Knowledge About Italian Legislation on Assisted Reproduction among Italian Academic Students. *Reproductive Biomedicine Online* 20(7) 873-879.
- 89 **Rudick, B., N. Opper, R. Paulson, K. Bendikson, K. Chung.** 2010. The Status of Oocyte Cryopreservation in the United States. *Fertility and Sterility* 94(7) 2642-2646.
- 90 **Sakka, S.D., D. Loutradis, C. Kanaka-Gantenbein, A. Margeli, M. Papastamataki, I. Papassotiropoulos, G.P. Chrousos.** 2010. Absence of Insulin Resistance and Low-Grade Inflammation Despite Early Metabolic Syndrome Manifestations in Children Born after in Vitro Fertilization. *Fertility and Sterility* 94(5) 1693-1699.
- 91 **Sandin, S., K.-G. Nygren, A. Iliadou, C.M. Hultman, A. Reichenberg.** 2013. Autism and Mental Retardation among Offspring Born after in Vitro Fertilization. *JAMA* 310(1) 75-84.

- 92 **Sauer, M.V., R.J. Paulson, R.A. Lobo.** 1992. Reversing the Natural Decline in Human Fertility: An Extended Clinical Trial of Oocyte Donation to Women of Advanced Reproductive Age. *JAMA* 268(10) 1275-1279.
- 93 **Sauer, M.V., R.J. Paulson, R.A. Lobo.** 1996. Pregnancy: Oocyte Donation to Women of Advanced Reproductive Age: Pregnancy Results and Obstetrical Outcomes in Patients 45 Years and Older. *Human Reproduction* 11(11) 2540-2543.
- 94 **Scherrer, U., S.F. Rimoldi, E. Rexhaj, T. Stuber, H. Duplain, S. Garcin, S.F. de Marchi, P. Nicod, M. Germond, Y. Allemann.** 2012. Systemic and Pulmonary Vascular Dysfunction in Children Conceived by Assisted Reproductive Technologies. *Circulation* 125(15) 1890-1896.
- 95 **Schieve, L.A., H.B. Peterson, S.F. Meikle, G. Jeng, I. Danel, N.M. Burnett, L.S. Wilcox.** 1999. Live-Birth Rates and Multiple-Birth Risk Using in Vitro Fertilization. *JAMA* 282(19) 1832-1838.
- 96 **Schwartz, C.R.** 2010. Earnings Inequality and the Changing Association between Spouses' Earnings. *AJS; American Journal of Sociology* 115(5) 1524.
- 97 **Schweizerische Gesellschaft für Reproduktionsmedizin.** 2013. *Fivnat Statistics 2013* http://www.sgrm.org/wb/media/FIVNAT/FIVNAT_Statistik_2013_vs_24_03_2015_English.pdf.
- 98 **Shaw, R.L., D.C. Giles.** 2009. Motherhood on Ice? A Media Framing Analysis of Older Mothers in the UK News. *Psychology & Health* 24(2) 221-236.
- 99 **Sheldon, T.** 2010. Dutch Medical Associations Support Freezing Oocytes for Non-Medical Reasons. *British Medical Journal* 341.
- 100 **Shkedi-Rafid, S., Y. Hashiloni-Dolev.** 2012. Egg Freezing for Non-Medical Uses: The Lack of a Relational Approach to Autonomy in the New Israeli Policy and in Academic Discussion. *Journal of Medical Ethics* 38 154-157.
- 101 **Shulevitz, J.** 2012. How Older Parenthood Will Upend American Society: The Scary Consequences of the Grayest Generation. *New Republic* 6 2012.
- 102 **Solé, M., J. Santaló, M. Boada, E. Clua, I. Rodríguez, F. Martínez, B. Coroleu, P. Barri, A. Veiga.** 2013. How Does Vitrification Affect Oocyte Viability in Oocyte Donation Cycles? A Prospective Study to Compare Outcomes Achieved with Fresh Versus Vitrified Sibling Oocytes. *Human Reproduction* 28(8) 2087-2092.
- 103 **statista.** 2016. Europäische Union: Fertilitätsraten in den Mitgliedsstaaten im Jahr 2014 <https://de.statista.com/statistik/daten/studie/200065/umfrage/geburtensziffern-in-ausgewaehlten-laendern-europas/>.

- 104 **Steiner, A.Z., R.J. Paulson.** 2007. Motherhood after Age 50: An Evaluation of Parenting Stress and Physical Functioning. *Fertility and Sterility* 87(6) 1327-1332.
- 105 **Stepan, H., S. Kuse-Föhl, W. Klockenbusch, W. Rath, B. Schauf, T. Walther, D. Schlembach.** 2015. Diagnosis and Treatment of Hypertensive Pregnancy Disorders. Guideline of DGGG (S1-Level, AWMF Registry No. 015/018, December 2013). *Geburtshilfe und Frauenheilkunde* 75(09) 900-914.
- 106 **Stoop, D., E. Maes, N. Polyzos, G. Verheyen, H. Tournaye, J. Nekkebroeck.** 2015. Does Oocyte Banking for Anticipated Gamete Exhaustion Influence Future Relational and Reproductive Choices? A Follow-up of Bankers and Non-Bankers. *Human Reproduction* 30(2) 338–344.
- 107 **Stoop, D., J. Nekkebroeck, P. Devroey.** 2011. A Survey on the Intentions and Attitudes Towards Oocyte Cryopreservation for Non-Medical Reasons among Women of Reproductive Age. *Human Reproduction* 26(3) 655-661.
- 108 **Svanberg, A.S., C. Lampic, P.-O. Karlström, T. Tydén.** 2006. Attitudes toward Parenthood and Awareness of Fertility among Postgraduate Students in Sweden. *Gender Medicine* 3(3) 187-195.
- 109 **Taylor, P.** 2010. The Decline of Marriage and Rise of New Families. *Pew Research Center. A.*
- 110 **Thomas, A.** 2012. Policy Solutions for Preventing Unplanned Pregnancy. *Center on Children and Families Brief 47.*
- 111 **Trokoudes, K.M., C. Pavlides, X. Zhang.** 2011. Comparison Outcome of Fresh and Vitrified Donor Oocytes in an Egg-Sharing Donation Program. *Fertility and Sterility* 95(6) 1996-2000.
- 112 **Tsafir, A., R. Haimov-Kochman, E.J. Margalioth, T. Eldar-Geva, M. Gal, Y. Bdolah, T. Imbar, A. Hurwitz, A. Ben-Chetrit, D. Goldberg.** 2015. Ovarian Stimulation for Oocyte Cryopreservation for Prevention of Age-Related Fertility Loss: One in Five Is a Low Responder. *Gynecological Endocrinology* 31(10) 779-782.
- 113 **Tur-Kaspa, I., M. Gal, A. Horwitz.** 2007. Genetics and Health of Children Born from Cryopreserved Oocytes. *Fertility and Sterility* 88 S14.
- 114 **Tymstra, T.** 2007. "At Least We Tried Everything": About Binary Thinking, Anticipated Decision Regret, and the Imperative Character of Medical Technology. *Journal of Psychosomatic Obstetrics & Gynecology* 28(3) 131-131.
- 115 **Villa, P.M., P. Marttinen, J. Gillberg, A.I. Lokki, K. Majander, M.-R. Ordén, P. Taipale, A. Pesonen, K. Räikkönen, E. Hämmäläinen.** 2017. Cluster Analysis to Estimate the Risk of Preeclampsia in the High-Risk Prediction and Prevention of Preeclampsia and Intrauterine Growth Restriction (Predo) Study. *PloS one* 12(3) e0174399.

- 116 **Virtala, A., S. Vilska, T. Huttunen, K. Kunttu.** 2011. Childbearing, the Desire to Have Children, and Awareness About the Impact of Age on Female Fertility among Finnish University Students. *The European Journal of Contraception & Reproductive Health Care* 16(2) 108-115.
- 117 **von Wolff, M.** 2013. «Social Freezing»: Sinn oder Unsinn? *Bulletin des médecins suisses / Schweizerische Ärztezeitung / Bollettino dei medici svizzeri* 94 10.
- 118 **Waldby, C.** 2015. 'Banking Time': Egg Freezing and the Negotiation of Future Fertility. *Culture, Health & Sexuality* 17(4) 470-482.
- 119 **Wallace, W.H.B., T.W. Kelsey.** 2010. Human Ovarian Reserve from Conception to the Menopause. *PloS one* 5(1) e8772.
- 120 **Wikland, M., T. Hardarson, T. Hillensjö, C. Westin, G. Westlander, M. Wood, U.-B. Wennerholm.** 2010. Obstetric Outcomes after Transfer of Vitrified Blastocysts. *Human Reproduction* 25(7) 1699-1707.
- 121 **Wirleitner, B., P. Vanderzwalmen, M. Bach, B. Baramsai, A. Neyer, D. Schwerda, M. Schuff, D. Spitzer, A. Stecher, M. Zintz.** 2013. The Time Aspect in Storing Vitrified Blastocysts: Its Impact on Survival Rate, Implantation Potential and Babies Born. *Human Reproduction* 28(11) 2950-2957.
- 122 **World Health Organization.** 2011. Global Health and Aging. National Institute on Aging, National Institutes of Health. NIH Publication no. 11-7737.
- 123 **Wunder, D.** 2013. Social Freezing in Switzerland and Worldwide – a Blessing for Women Today? *Swiss Medical Weekly* 143(February) w13746.
- 124 **Wunder, D.** 2014. Höchstalter der Frau für Fortpflanzungsverfahren. *Gutachten zuhanden des Bundesamtes für Gesundheit (BAG).*

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National Advisory Commission on Biomedical Ethics NCE

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PD Dr. med. Dorothea Wunder*

*Members of the working group responsible for preparation of the opinion

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Office

Responsible for the Office

Dr. rer. soc. Elisabeth Ehrensperger

Scientific collaborator

Dr. phil. Simone Romagnoli

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National Advisory Commission on Biomedical Ethics NCE

CH-3003 Bern

Tel. +41 (0)58 464 02 36

Fax +41 (0)58 462 62 33

info@nek-cne.admin.ch

www.nek-cne.ch