

## Is Freezing the Future? Investigating Interest of Elective Oocyte Freezing Amongst Singaporean Women

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### Abstract

A novel technological innovation called Elective Oocyte Freezing (EOF) has emerged as a solution for women who wish to preserve their fertility to delay childbearing for non-medical reasons. This technology has grown in popularity as women have undertaken a greater role in the workforce and faced the dilemma of balancing work and family. In spite of the rising trend of Singaporean women postponing childbearing to advance their careers, EOF is currently prohibited in Singapore. Many Singaporean individuals have declared this policy to be both outdated and a threat to women's reproductive rights. However, prior to this survey, no research, to my knowledge, has analyzed Singaporean female professionals' interests in EOF, if made available. Through this quantitative, cross-sectional, 4-part survey, I conclude that if EOF was permitted, encouraged, and subsidised by the Singaporean government, Singaporean women possess a strong interest in freezing their eggs for social purposes. This paper further demonstrates an existing positive relationship between 48 Singaporean female professionals' interest in EOF prior to and following reading an information leaflet. Specifically, after being informed of the social benefits presented by EOF, participants were significantly more inclined to freeze their eggs if such practice was permitted in Singapore. This conclusion suggests that the Singaporean government should re-evaluate their position on EOF in order to facilitate childbearing dilemmas faced by the increasing number of women entering the country's workforce each year. Additionally, as this policy is currently a subject of debate in Singapore, the implications of this research, revealing Singaporean female professionals' interest in EOF, create a foundation for both future research and the possible evaluation of this policy. If this conclusion is corroborated with subsequent research, further evidence may substantiate my findings regarding the desires of Singaporean women and possibly result in a change of legislation.

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## Introduction

### *Context*

In recent years, women have increasingly entered public spheres of activity. As a result of this increased involvement, many women are choosing to have their first child at an older age, globally known as delayed childbearing [30]. Professional women are additionally faced with the dilemma of balancing work and family, making employment a "critical factor" of delayed childbearing [30]. In order to confront this dilemma, a "novel technological innovation" is being commercialized to women who wish to postpone motherhood for non-medical reasons: Elective Oocyte Freezing (EOF) [4]. EOF is defined as the act of freezing and storing a woman's oocytes, or eggs, for non-medical purposes to preserve a woman's reproductive potential for future use [4]. Women who opt for this treatment often do so because they are prioritizing developing a career; however, it can also be an option for women in the absence of a partner [4]. This practice has acted as a solution for many women around the world faced with the aforementioned dilemmas of delayed childbearing [4].

### *Singapore Gender-Role Policies*

Following the 1950s, as Singapore transformed from a small fishing village to "an economic giant of the Asia-Pacific region," the efforts of the Singaporean government put forth efforts to encourage female participation in the labor force were evident [14].

Through the Foreign Domestic Maid Scheme of 1978, for example, the government partly subsidized maid's salaries, which allowed more families to hire a maid to manage household work. As a result, more women joined the workforce [14]. However, policymakers soon feared that the mobilization of women into the workforce would threaten social order and the "displacement of women's traditional role at home" [14]. In order to preserve Singapore's traditional social structure, policies were introduced that "not only directly stressed women's roles as mothers and family caretakers," but also "indirectly affected women's decisions about entering the job market" [14]. For instance, in 1979, the government retracted the number of female medical students at the National University of Singapore by "one-third of the total intake" [14]. In

essence, as Singapore has progressed, many of their policies continue to prioritize women fulfilling more traditional child rearing roles rather than entering the workforce

### *The Social Argument*

Over the past few decades, the global trend of delaying childbearing in high-income countries has emerged due to investment in education, development of a professional career, and difficulties in finding a partner [5]. For instance, the median age of Singaporean females having their first child in 2000 was 28.6 [15]. In 2011, however, the median age of women having their first child rose to 29.8, and continues to show such patterns of growth today [15].

Unfortunately, as delayed childbearing trends increase, many problems emerge for women. Prior to the age of 30, women have an 85% chance of conceiving within a year [5]. However, due to the effect of aging on both women's ovaries and oocytes, this chance drops to 66% by the age of 35 and 44% by the age of 40 [5]. Thus, many women who delay childbearing experience increased difficulties when trying to get pregnant.

Through preserving the fertility and reproductive potential of a woman's oocytes, EOF serves as "insurance" to help women conceive at later ages [13]. Therefore, as Singaporean women are delaying having children for non-medical purposes, this emerging technology could help reduce the concerns of women who wish to postpone motherhood.

### *The Existing Law*

In spite of the social benefits of EOF, the practice is currently prohibited in Singapore under section 6(5), Clause 5.39 of the Private Hospitals and Medical Clinics Act on Assisted Reproductive Services, reading [2]

Essentially, healthy women at peak fertility are not permitted to freeze their eggs under Singapore's existing policy [13]. Instead, the Ministry of Health only permits egg-freezing for medical purposes, including for women undergoing chemotherapy and radiotherapy treatments that may impair their fertility [13].

International stances regarding EOF differ drastically. In the United States, for example, companies

*Clause 5.39 of the Private Hospitals and Medical Clinics Act*

“AR Centres shall only store gametes and embryos if such storage is medically indicated or where the gametes and embryos have been donated for research” (“Assisted Reproductive Services”).

such as Facebook and Apple have subsidized EOF in their employee benefit packages to retain female workers [16]. Furthermore, EOF is practiced globally as it is either legalized in countries such as Canada, Australia, and the United Kingdom or simply unregulated in countries such as India, Malaysia, and Thailand [13].

In order to properly assess Singapore’s reasoning behind prohibiting EOF, it is important to understand the medical risks and benefits of the practice. In 2012, Dr. Amy Khor, a Singaporean Member of Parliament, addressed the rationale for this law, explaining that there are “inherent risks to the women who undergo the egg-freezing procedure” [13]. Such risks include ovarian hyper-stimulation syndrome (causing the painful swelling of ovaries), bleeding, and infection [13]. Moreover, as egg-freezing technology is relatively new, limited information exists on the “perinatal outcomes of the procedure,” such as the success rates and live births [13]. In addition to the medical implications, Dr. Khor believes the over-commercialisation and misconception of the use of EOF as guaranteed fertility preservation will create social and ethical implications [13]. In opposition, The Israeli Ministry of Health has expressed its support for EOF, claiming that since oocyte freezing “carries no greater risk” to a woman than the use of a fresh egg in a standard IVF procedure, EOF is an “accepted practice” [21].

In regards to the ethicality of EOF, insufficient data on this novel technology gives women a “false sense of security” [13]. Nonetheless, medical experts believe that as long as there is an “importance placed on informed consent,” adults should have freedom to preserve their fertility for non-medical reasons [21]. Thus, these assertions suggest that the medical efficacy

and ethicality of EOF are not the main concern prohibiting the practice in Singapore.

Alternatively, the current legislation is highly attributed to the social goals of the Ministry of Social Family and Development. The ministry encourages Singaporeans to “fulfil their marriage and parenthood goals as early as possible” [17]. Additionally, the ministry believes that allowing EOF will “inadvertently (cause) more to delay marriage or parenthood based on a misperception that (women) can have a child whenever they wish to” [17]. However, as aforementioned data revealed, Singaporean women are continuing to delay child bearing regardless of access to EOF [15]. Thus, permitting EOF could perhaps support the existing positive growth of working Singaporean females faced with choosing between their career and starting a family

*Previous Research*

As medical technologies advance and delayed childbearing rates escalate, EOF has strived to appeal to young women around the world. Research has shown that EOF offers “important benefits to women who anticipate becoming pregnant at an advanced age” [18]. Despite these findings, limited research exists on women’s motivations and interest in freezing their eggs, especially in Singapore. In this section, I will review some of the studies that have examined women’s interests and engagement in EOF.

In order to predict Singaporean women’s interest in EOF, we must analyze the interests of women in other developed countries where EOF is permitted. Marcia Inhorn, an anthropology professor at Yale University, utilized a binational analysis to compare the socio-demographic factors that led women to freeze their eggs in the U.S. and Israel. The study found that in

both Israel and the United States, the lack of a stable partnership and career building were primary motivators leading women to freeze their eggs [11]. Moreover, the women surveyed overwhelmingly admitted to not intentionally delaying their careers, but were instead attempting to grapple with gender-based socio-demographic disparities beyond their "individual reproductive control" [11]. Essentially, participant's interests in EOF were not based on choice, but rather an "undesired and circumstantial" last resort to preserve their reproductive potential while maintaining success in the workforce [11].

In addition to the motivations of women who have already frozen their eggs, it is also important to highlight the interest and awareness of EOF amongst women who have not previously considered the procedure. In a qualitative survey conducted by Courtney Stanton, the Associate Director of Takeda Pharmaceuticals, the interest and awareness of EOF was analyzed amongst women in the U.S. between the ages of 25 to 35. The findings of this study revealed that 61% of participants expressed "moderate to extreme interest" in EOF after learning about the treatment [24]. Respondents found EOF appealing for three main reasons: they could focus on their career, not rush to find a partner, and wait until they were financially ready to have children [24]. Even though 58% of participants believed that the treatment may be too expensive, overall, participants "indicated a willingness to spend an average of \$3,050" USD to freeze their eggs [24]. Overall, this study highlights that after learning about EOF, young women reported an interest in freezing their eggs for non-medical purposes.

Contrary to the interest reported in previous studies, Johanna Kostenzer's Q-methodology study introduces a new viewpoint regarding EOF found amongst surveyed women in Austria, another country which prohibits EOF (Kostenzer). In this study, Kostenzer identified a common viewpoint amongst participants: "prolonging fertility beyond the fertile life age" is unnatural, and thus should not be permitted through EOF (Kostenzer). Supporting this viewpoint, one participant claimed in the qualitative interview that egg freezing "should - if at all - only be allowed in exceptional cases" (Kostenzer)

Essentially, women in countries that permit EOF, such as the U.S., have shown interest in the treatment, as demonstrated in Stanton's study. On the other hand, concerns persist amongst women in countries that do not permit EOF, such as Austria.

Differences in perceptions of women internationally, as well as their level of interest in the procedure, beg the question of interest within Singapore. In a cross-sectional survey by the Journal of Obstetrics and Gynecology Research, Dr. Shu Qi Tan, a medical officer of KK Women's and Children's Hospital, breached the surface of this discussion. In her study, Dr. Tan surveyed medical students, assuming that EOF awareness is "higher among this medically inclined group" [27]. When asked if participants would consider EOF, 70% reported interest in the practice, leading Dr. Tan to conclude that EOF is a "viable option for single young women" looking for reproductive insurance [27]. Overall, while this demonstrates an interest amongst medical students in Singapore, there is still more research to be done regarding the motivations, interest, and projected use of Singaporean women overall.

In summary, while participants in Kostenzer's study disapproved of EOF, the findings by Tan, Inhorn, and Stanton highlight the existing interest and various motivations leading many women to freeze their eggs. Altogether, these findings demonstrate the research that has been conducted on this topic, as well as reveal the potential gaps in the research, acting as a basis for further investigation.

#### *Purpose and Significance*

Although studies have explored the interests of women around the world in freezing their eggs, the extent to which permitting EOF in Singapore would appeal to a range of Singaporean women has yet to be investigated. Such a study could contribute to this field of research by highlighting unexplored interest that Singaporean women may have on a procedure that is both growing in public interest and is "revolutionary for women's choices"[9].

Specifically, the question I intend to answer is: *through a quantitative cross-sectional study, to what extent would government measures to permit Elective*



*Oocyte Freezing in Singapore increase Singaporean female professionals' reported interest in the procedure?*

The initial hypothesis is that after learning about EOF, Singaporean female professionals will be more interested in freezing their eggs if government actions are taken to legalize, encourage, and subsidize EOF in Singapore. In other words, women would be highly interested in EOF to preserve their oocyte's reproductive potential and delay childbearing.

Currently, an estimated small number of Singaporean women have travelled overseas to freeze their eggs for elective purposes. A quantitative study conducted by Clearstate, a Healthcare Research Consultancy, explored the annual number of Singaporeans that freeze their eggs at fertility clinics in countries nearby to Singapore. In Thailand, the interviewed fertility clinics see an average of 10 Singaporean couples each year [26]. Similarly, the interviewed fertility clinics in India see on average 5 Singaporean couples each year [26]. While these findings demonstrate the interest of Singaporean women to partake in EOF, a limitation exists: cost.

The cost of storing eggs ranges from \$600-1,000 SGD a year, and in Thailand, the cost of using stored eggs to undergo In Vitro Fertilization (IVF) treatment ranges from \$6,000-7,5000 SGD per cycle [26]. As the average monthly earning of a Singaporean woman in 2019 was only \$4,872 [10], the cost of the treatment in addition to travel fees makes EOF unaffordable for many Singaporean women. Additionally, due to Singapore's strict travel restrictions amidst the Covid-19 pandemic, this option has even become infeasible for those who can afford the high prices [22].

In March 2021, Cheng Li Hui, a Singaporean Member of Parliament, proposed the revisitation of existing policy on EOF [22]. Hui argued that the government should "relook voluntary egg freezing and open [their] hearts and minds to support the hopes and dreams of many families here in Singapore" [22]. As this policy is currently a trending topic of discussion, this data could assist in not only reporting female interest in EOF, but incentivizing long awaited change

of the existing policy.

## Method

### *Data Collection*

#### *Quantitative Cross-Sectional Research*

In this study, I utilized a quantitative cross-sectional method. Quantitative methods "emphasize objective measurements and the statistical, mathematical, or numerical analysis of data" in order to collect numerical data and "generalize it across groups of people" to explain a phenomenon [20].

Cross-sectional studies are defined as "observational studies that analyze data from a population at a single point in time," or in other words, taking a "snapshot of a group of individuals" [28]. Unlike cohort studies, where subjects are "selected based on the exposure status," cross-sectional study subjects are chosen from an "available population of potential relevance to the study question" [28]. In this study, a "snapshot" will be taken on my subjects' interest in partaking in EOF at this time of their lives.

### *Cohort*

The participants of this survey comprise 48 Singaporean female professionals between the ages of 20 to 39. I chose to survey only females as egg-freezing does not require sperm – unlike fertilized egg-freezing, the more commonly used IVF treatment, does ("Egg Freezing") [8]. Since this procedure does not rely on the involvement of males, female opinions are of utmost importance to consider when assessing interest in EOF.

Additionally, for this study, a professional will be defined as "a person who has the type of job that needs a high level of education or training" [19]. This includes, but is not limited to, teachers, doctors, accountants, editors, lawyers and authors [3]. I focused on professional women as professionals with "greater career involvement and higher wage(s) are more likely to delay first births" and remain childless compared to women in lower ranking positions [29].

Lastly, from 2000 to 2011, the percentage of childless women between the ages of 30 to 39 rose 8.6% - higher than any other age group recorded [23]. Since women within this age group are experiencing

such drastic shifts in their fertility rates, their views are important to consider. Similarly, as this study is regarding a change in legislation, the views of future generations are equally important to examine. Consequently, I chose to survey women between the ages of 20 to 29 in addition to women between the ages of 30 to 39. I collected participants by emailing my survey to women's rights organizations in Singapore, such as the Association of Women for Action and Research (AWARE).

## *Survey*

### *Introduction*

I began by creating a 3-part survey using Google Forms. Prior to the questionnaire, I provided an introduction including minimal information about the study. The introduction is included below in Appendix A.

### *Demographic Information Sheet and Initial Assessment Questions*

The first section of this survey included two parts: a Demographic Information Sheet (DIS) and Initial Assessment Questions about EOF. The questions were derived from my seminal source, a study by the Journal of Obstetrics and Gynecology Research entitled "Social Oocyte Freezing: A Survey Among Singaporean Female Medical Students" [27]. In this study, the aforementioned Dr. Shu Qi Tan, a consultant at the KK Women's and Children's Hospital, used these questions to assess the "awareness of the existence of social oocyte freezing" amongst participants. The DIS and Initial Assessment Questions are outlined below in Appendix B.

### *Information Leaflet*

After completing the Demographic Information Sheet and the Initial Assessment multiple-choice questions from Section 1, participants were asked to read an information leaflet, which was derived from Tan's study [27]. This leaflet included information on the success rates, history, cost, and procedure of oocyte freezing. The purpose of the leaflet was to educate participants on the treatment so they could provide informed answers in the following section. I included an additional paragraph that recognized the existing policy regarding EOF in Singapore as Dr. Tan's leaflet did not include this information. The paragraph I included will be

marked with an asterisk (\*). The information leaflet is included below in Appendix C.

### *Likert-Scale*

Ultimately, after reading the information leaflet, participants concluded the survey by responding to prompts on a Likert-Scale. These prompts focused on the participants' "intentions for (EOF) if made available" in Singapore [27]. In Dr. Tan's study responses were collected by asking participants multiple choice questions. However, using a Likert-Scale in quantitative studies allows researchers to strongly "quantify people's opinions, interests, or perceived efficacy of an intervention" [1]. Therefore, while this section was modelled after Dr. Tan's study, I adapted Tan's multiple choice questions to statements on a Likert Scale, with 5-sections: "Strongly Agree," (5) "Agree," (4) "Undecided," (3) "Disagree," (2) and "Strongly

Disagree" (1). I chose to use a 5-point scale to ensure I was collecting the most diverse data. The following statements are included below in Appendix D.

### *Data Organization*

After collecting my responses, I closed the survey and transferred the collected data into Google Sheets. The results are included in Appendix E.

In each row, the most selected sentiment is highlighted. For example, in response to the statement "If Medisave covered oocyte freezing, I would be more amenable to freezing my eggs," the majority of participants responded by selecting "strongly agree." Thus, that box is highlighted.

Following the organization and grouping of the general collected data, I grouped responses into three subgroups, based on age, religion and responsiveness to information on egg freezing. In addition, participants responded both before and after reading the information leaflet to a question regarding their interest in freezing their eggs.

### *T-test, Standard Deviation and Mean*

Once all the data was organized, I calculated whether or not the difference between each subgroup was statistically significant using a two-sample t-test. This test compares the means of two independent

groups to determine whether statistical evidence indicating that two groups are significantly different exists [25]. After entering the mean and standard deviation of both data sets, a p-value is calculated, either rejecting or accepting the hypothesis. If the p-value is less than 0.05, the data is statistically significant[6].

*Subgroup Findings*

*Age Group*

The first subgroup I analyzed was based on age. The general cohort, ranging from Singaporean women between the ages of 20 to 39, were split into two subgroups. The first group, comprising 20 participants, included women aged 20 to 29. The second group, comprising 28 participants, included women aged 30 to 39. For each statement presented on the Likert-scale, I used the aforementioned t-test method to calculate whether the difference in responses between the two age groups were statistically significant. The data for two of the eight statements are included in Table 1.

The p-value calculated for all 9 statements

between both age groups proved to be statistically insignificant, confirming the null hypothesis that no statistically significant difference exists based on the age of participants. In other words, the p-value was always greater than 0.05, which indicates that there is no statistically significant difference in regards to interest in egg freezing based on age. As shown above in Table 1, the lowest p-value calculated was in response to the statement "I would consider oocyte freezing to focus on my career and postpone family planning."

*Religion*

The second variable I analyzed was based on the religious affiliations of the participants.

As many religious groups are "strongly opposed" to egg freezing [13], I wondered if religiously unaffiliated participants were more likely to show interest in EOF compared to religiously affiliated participants. Out of the 48 participants, 15 were non religiously unaffiliated, while the remaining 33 were affiliated with one of five religions: Hinduism, Catholicism, Buddhism, Christianity, and Islam. The

Table 1. Age Group

I would consider freezing my eggs at some point in time (after reading the information leaflet)		
	Age Group 20-29	Age Group 30-39
Mean	3.8	3.571428571
Standard Deviation	1.151657844	0.8789122667
p-value from t-test: 0.4608620538		
I would consider oocyte freezing to focus on my career and postpone family planning		
	Age Group 20-29	Age Group 30-39
Mean	3.7	3.29
Standard Deviation	1.031095483	0.9533267587
p-value from t-test: 0.1784483988		

Table 2. Religion

I would consider freezing my eggs at some point in time (after reading the information leaflet)		
	Non-Religious	Religious
Mean	3.733333333	3.625
Standard Deviation	0.8837151017	1.070122091
p-value from <i>t</i> -test: 0.7170784456		
Social egg freezing should be offered to women of all ages		
Mean	4.466666667	3.96875
Standard Deviation	0.5163977795	1.062084833
p-value from <i>t</i> -test: 0.03596963382		

Table 3. Response to the Information Leaflet

I would consider freezing my eggs at some point in time		
	Before Reading Information	After Reading Information
	Leaflet	Leaflet
Mean	2.145833333	2.416666667
Standard Deviation	0.8789122667	1.151657844
p-value from <i>t</i> -test 0.0388948947		



data for two of the eight statements are included in Table 2.

Out of all 9 statements, only one proved to have a statistically significant difference on the basis of religion: "Social egg freezing should be offered to women of all ages." This analysis highlights that non-religious Singaporean women are more accepting of the idea of allowing

women of all ages to freeze their eggs compared to their religious counterparts. However, in terms of participants' personal interest, which were addressed in the remaining 8 statements, no statistically significant difference was found between non-religious and religious participants.

#### *Response to the Information Leaflet*

The last variable I analyzed using the t-test was whether participants' interest changed after reading the information leaflet. Prior to reading the information leaflet, in Section 1 of the survey, participants were asked "Would you consider freezing your eggs at some point in time?" Participants responded to this question by selecting one of three response options: "Yes," "I don't know" and "No," which represented values 3, 2, and 1, respectively. Similarly, after reading the information leaflet, in Section 3, participants responded to the statement "I would consider freezing my eggs at some point in time" presented on the 5-point Likert-Scale. The response options ranged from "Strongly Agree" (5), "Agree" (4), "Undecided" (3), "Disagree" (2), and "Strongly Disagree" (1). I assessed whether the differences in responses before and after reading the information leaflet were statistically significant. If the difference were statistically significant, such results could reveal the importance of informing Singaporean women about EOF to accurately assess their interest.

While calculating the p-value for these two values, a limitation emerged. Since the Section 1 question was presented on a 3-point scale whilst the Section 3 prompt was presented on a 5-point scale, I could not directly compare the two sets of data. In order to create the most accurate comparison, I converted both scales to 3-point scales. I accomplished this by having both "strongly agree" and "agree" represent 3, "undecided" represent 2, and both "disagree" and

strongly disagree" represent 1 for the Section 3 responses to align with Section 1's 3-point scale. The data for the before and after question is included in Table 3.

Overall, the difference in interest amongst all 48 participants proved to be statistically significant, resulting in a p-value of 0.03. Participants were significantly more likely to express interest in EOF subsequent to reading the information leaflet, which included information about the cost, success rates, and social benefits provided by social egg freezing. This demonstrates the importance of educating Singaporean women about egg-freezing in order to accurately assess their interest.

#### **Conclusion**

##### *Discussion of Results*

Ultimately, these findings support the initial hypothesis that after learning about EOF, Singaporean female professionals would be more interested in freezing their eggs if government actions are taken to legalize, encourage, and subsidize EOF in Singapore. The average response to all 9 prompts assessing women's interest in EOF lied between 3 and 5, or "undecided" and "strongly agree." This indicates that the majority of participants demonstrated at least some interest or consideration in regards to freezing their eggs. More specifically, participants were most interested in freezing their eggs if the treatment was subsidized by the government or covered by Singapore healthcare programs, such as MediShield Life.

The results of this study suggest that women are interested in freezing their eggs and would likely do so if further steps were taken by the Singapore government to legalize, encourage, and subsidize EOF in Singapore. With respect to the age group and religious affiliation of the participants, no significant difference in responses were identified. This signifies that Singaporean females between 20-39, whether they are religiously affiliated or not, are likely to express interest in freezing their eggs. While the variables of age and religion proved to be statistically insignificant, one variable did result in a significant difference: the presence of an information leaflet. Participants were significantly more likely to express interest in

egg-freezing subsequent to reading the information leaflet, which included information about the cost, success rates, and social benefits provided by EOF, highlighting the importance of educating Singaporean women about EOF to accurately assess their interest.

#### *Limitations*

While this study provided new insights into the interest of Elective Oocyte Freezing amongst Singaporean female professionals, the limitations of this research must be addressed.

An initial limitation to this study was the sample size of 48 participants. While participants ranged in age groups, religious affiliations, and races, the interests of 48 participants is not representative of the entire population of Singaporean female professionals. If this research were to be used to provide a strong argument as to why legalizing EOF in Singapore would reflect Singaporean's best interests, more participants are needed.

Another limitation to this research is that as the survey was sent out electronically and recorded anonymously, I was unable to account for who had and had not completed the survey. Therefore, it is important to recognize that those who did participate in the survey might have had an inherent bias or prior interest in freezing their eggs, as opposed to those who chose not to take the survey. Unfortunately, due to the feasibility and confidentiality of this survey, this limitation is unavoidable.

Lastly, participants were collected through Singaporean women's rights organizations, such as AWARE, who have previously lobbied in support of policy to expand female reproductive rights. Thus, associated participants may have been more amenable to the idea of legalizing a practice like EOF. In future research, participants should be selected through a method that is more random of the population as a whole to reduce bias.

#### *Further Research*

While there are limitations to be accounted for, ultimately, the findings of this survey provide a gateway for future research on egg-freezing in Singapore, an ever-evolving topic of discussion. This study has scratched the surface of the gap of research regarding

Singaporean female professionals' interest in freezing their eggs if EOF was permitted. However, if Singaporeans want to provide sufficient reasoning as to why reforming the current policy on egg freezing is necessary, further research must be completed.

In subsequent studies, researchers should examine the effects that permitting EOF would have on familial structures and culture in Singapore. For instance, the aforementioned Ministry of Social Family and Development worry that egg freezing will "inadvertently [cause] more to delay marriage or parenthood" [17]. Therefore, research that counters these government fears could be influential in shifting the government's opinion on the matter. In other words, through research revealing that permitting egg freezing will not disrupt Singapore's ideal family structure, the Ministry of Social Family and Development may be more amenable to repealing the existing policy on EOF.

Similarly, in 2019, the Singaporean government declared that they are working to create more opportunities for citizens to play a "bigger role" in addressing policy making issues [12]. In order to provide concrete evidence as to why permitting EOF would reflect public interest, further research should continue to measure the interest of overall Singaporean women. This research should be conducted with a much greater sample size, which will better represent the attitudes of Singaporean women overall.

Another aspect to address in future research is the effect permitting egg freezing could have on increasing Singapore's low fertility rate. Ever since reaching "below replacement" fertility levels in 1975, Singapore has been suffering an extremely low fertility rate [7]. While policymakers assumed that low fertility rates could be "overcome by dealing with young people as selfish, cost-benefit calculating individuals," this was not the case [13]. In fact, many Singaporean women suggest that "the problem does not lie with the motivations of young people themselves," but instead, "with the nature of the societies they live in" [13]. For example, due to preconceived cultural gender biases, women needed to believe that they can pursue their employment goals while simultaneously having the number of children they wished to have [13]. Essentially, financial incentives have been unsuccessful

in appealing to women as their reasons for delayed childbearing stray from merely concerns of economic stability.

Instead, in order to increase Singapore's fertility rate, the government should "change the economic and social institutions, regulation affecting working conditions, and popular norms" to more readily combine work and child-rearing[7]. This combination of work and motherhood is exhibited through the previously mentioned social benefits offered by EOF. Therefore, determining whether EOF would lead to women wanting more children could be valuable

information for the Singaporean government, who is continuing to search for efficacious methods to increase the country's fertility rate.

Overall, as this discussion on whether egg-freezing should be permitted in Singapore persists, especially with the call to action by MP Cheng Li Hui, this study and further research will be essential to reverse Singapore's outdated policy. More importantly, it will provide Singaporean women with reproductive insurance so they no longer have to make the difficult choice between work and family.

#### Appendix A: Survey Introduction

Hello,

My name is Sara Bach, and I am an 11th grade student at the Singapore American School. I am currently taking a course entitled Advanced Placement Research.

At this stage of the course, students are in the process of creating a pilot study. It would be of great help if you could complete the following three sections including answering a list of short preliminary questions, reading an informational leaflet, and answering a set of in-depth questions.

If you have further questions or care to rescind your response due to personal concerns, please email me at [bach43196@sas.edu.sg](mailto:bach43196@sas.edu.sg). The responses to this survey are anonymous and will only be used to conduct research for this pilot study. Thank you so much for participating in this survey!

Appendix B: Demographic Information Sheet and Initial Assessment Questions

1. What is your race? <input type="radio"/> Chinese <input type="radio"/> Malay <input type="radio"/> Indian <input type="radio"/> Others (please specify: _____)
2. What is your age? _____
3. What is your religion? <input type="radio"/> Buddhist <input type="radio"/> Muslim <input type="radio"/> Christian <input type="radio"/> Hinduism <input type="radio"/> Catholic <input type="radio"/> Non-religious <input type="radio"/> Others (pls specify: _____)
4. Do you plan to have children? <input type="radio"/> Yes <input type="radio"/> No
5. At what age do you plan to have your first child? <input type="radio"/> 21–25 <input type="radio"/> 26–30 <input type="radio"/> 31–35 <input type="radio"/> 36–39 <input type="radio"/> >40
6. Will you delay family planning for your career? <input type="radio"/> Yes <input type="radio"/> No
7. If so, are you worried about impaired fertility due to advanced age? <input type="radio"/> Yes <input type="radio"/> No
8. When do you consider yourself too old to get pregnant? <input type="radio"/> >21 <input type="radio"/> >26 <input type="radio"/> >31 <input type="radio"/> >35 <input type="radio"/> >40
9. What do you think is the upper age limit for pregnancy? i.e., when is it not acceptable for a woman to get pregnant? <input type="radio"/> >45 <input type="radio"/> >50 <input type="radio"/> >55 <input type="radio"/> >60
10. Would you consider freezing your oocytes at some point in time? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I do not know
11. At what age would you consider oocyte freezing? <input type="radio"/> 21–25 <input type="radio"/> 26–30 <input type="radio"/> 31–35 <input type="radio"/> 36–39 <input type="radio"/> >45

## Appendix C. Information Leaflet

This information leaflet is derived from a study completed by the Journal of Obstetrics and Gynaecology Research by Dr Tan Shu Qi, Medical Officer of KK Women's and Children's Hospital. Please read and respond to the questions on the following

### *Purpose of the Research Study*

There is an increasing trend for young women to delay their childbearing plans till later in their reproductive years. This is largely attributed to postgraduate academic pursuit and higher levels of professional achievement. Studies have shown a trend for young women to delay their child bearing age. However, the ability to conceive is strongly influenced by a woman's age. Older women more commonly experience subfertility by the time they are ready to become pregnant. As many women started to become aware of the age-related decline in fertility, interest in the emerging technologies of fertility preservation has grown. Our study aims to look at societal opinions on social oocyte freezing to halt the effects of time on reproductive function.

### *Natural Fecundity*

Fecundity refers to the ability to reproduce. The fertility of a woman is mainly influenced by her age. The progressive loss of oocytes that occurs from fetal life until menopause is one of the defining features of the age-related decline in female fertility. The oocyte pool peaks at birth. Subsequently, progressive atresia occurs, and happens at an accelerated rate after the age of 37 in normal women till menopause. As the number of oocytes declines over time, the quality of oocytes also declines, resulting in an increased prevalence of aneuploid oocytes due to dysfunctions of the meiotic spindle. Studies have consistently demonstrated a decline in pregnancy rates with advancing maternal age, with higher rates of miscarriage among older women. These relationships are best illustrated by outcome data from clinics performing in vitro fertilization. With age-related decreasing fecundity coupled with the delay in childbearing age in modern society, Leridon et al.<sup>1</sup> have shown that this has resulted in an up to 73% increase in need for fertility treatments

### *Information about Oocyte Freezing*

The first successful pregnancy from oocyte cryopreservation was reported in 1986. However, oocyte freezing is still regarded as a relatively experimental procedure by most major regulatory bodies in the United States and Europe, particularly for social Indications. This is due to concerns about the procedure's success rates and safety for future offspring. However, with improving techniques like vitrification for oocyte freezing, there is an increasing trend for social oocyte freezing, especially in ladies who are postponing childbirth to a later age. For women who do not have a participating male partner and are not interested in using donor sperm, oocyte cryopreservation is generally the preferred option until a suitable partner is found

### *Oocyte Freezing*

Traditionally, oocytes are frozen via slow freeze method, but with poor outcomes. Vitrification is a relatively new approach to oocyte freezing. The first reported live birth from vitrified human oocytes was in 1999. It is based upon the principle that metabolically active cells can be cooled so rapidly that ice does not have time to form. Successful use of vitrification procedures has been reported in animal models, and the number of human live births resulting from vitrification of oocytes is encouraging. Several case series showing promising results have been published. A meta-analysis including five reports on vitrification estimated fertilization rates of 74 percent (637/859), clinical pregnancy rates per transfer of 45.5 percent (61/134), and live birth rate per transfer of 36.6 percent (49/134).

### *Procedure*

Potential candidates will generally undergo baseline ovarian reserve testing prior to initiating treatment. The processes of embryo and oocyte cryopreservation are identical to that of in vitro fertilization up until the time of the oocyte retrieval. Controlled ovarian hyperstimulation with daily injectable gonadotropins is initiated in the early follicular phase or after an interval on the birth control pills, and continues for approximately 10 to 14 days to achieve multiple peri-ovulatory follicles. The oocyte



retrieval is performed via needle aspiration utilizing transvaginal ultrasound guidance, typically under conscious sedation. Mature oocytes retrieved are frozen on the day of the oocyte retrieval. For sufficient oocyte collection (usually about 20 oocytes), 3 cycles of oocyte stimulation and retrieval are usually required. COST The cost of embryo and oocyte cryopreservation procedures is comparable to that of in vitro fertilization. A single cycle including monitoring visits, surgical, anaesthesia and embryology is approximately \$8000. For 3 cycles, the cost is estimated at \$24 000. Annual storage fees are approximately \$400 per year. LONG TERM FOLLOW UP OF CHILDREN There is limited data on the long term follow up of children for oocyte vitrification techniques. In the largest study, Chian et al.<sup>3</sup> (2008) reported data on 200 children. The mean birth weight was 2920 grams for singletons and 2231 grams for multiples. The low birth weight rate among singletons was 18% and among multiples 80%. The premature delivery rate was 26% for singletons and 71% for multiple pregnancies. The incidence of congenital malformations was 2.5%. A review by Wennerholm et al.<sup>4</sup> revealed a total of 221 successful infants born via this technique, but there is no long term child follow up data for cryopreservation techniques as of now

#### *Existing Law*

In Singapore, however, under section 6(5) of the Private Hospitals and Medical Clinics Act on Assisted Reproductive Services, known as CAP 248, clause 5.39 states that "AR Centres shall only store gametes and embryos if such storage is medically indicated or where the gametes and embryos have been donated for research," signifying that Singaporean women are unable to freeze their eggs for non-medical or social purposes. With this law, various problems emerge for Singaporean women. As women's oocyte fertility begins to decrease in their 30s, making it more difficult for older women to have children, by prohibiting oocyte freezing for social purposes, Singaporean women could potentially be faced with the predicament of whether to risk advancing their careers to get married and start a family while their eggs are still fertile or risk having kids to achieve leadership positions in the workforce (Khoo 2014) [13]. However, if EOF was permitted, it could allow women who sacrificed having kids for their

careers to freeze their eggs and start a family later on in life. Currently, international perspectives on Elective Oocyte Freezing differ drastically. In the United States, for example, companies such as Facebook and Apple had included "oocyte cryopreservation," or EOF, in their employee benefit packages up to \$20,000 (Mertes, 2015) [16]. Furthermore, a combination of surveys conducted by Clearstate, a Healthcare Research Consultancy, emphasizes how in countries such as Malaysia, Thailand, India, and Australia, EOF is either permitted or unregulated, yet practiced. Overall, as other developed countries have been permitting, and even encouraging, Elective Oocyte Freezing, it is important to consider whether or not Singaporean women could also benefit from the potential social and workplace advantages of Elective Oocyte Freezing.

#### **Conclusion**

Vitrification of oocytes promises to be an effective method of fertility preservation for women. We would like to gauge the opinion of future professional women, such as yourself, on fertility preservation with oocyte cryopreservation.

Appendix D: Likert-Scale

1. I would consider oocyte freezing if I have no suitable partner yet  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
2. I would consider oocyte freezing to focus on my career and postpone family planning  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
3. Even if I had to pay with self-cash, I would still be interested in freezing my eggs  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
4. If Medisave covered oocyte freezing, I would be more amenable to freezing my eggs  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
5. If there is government subsidy available for oocyte freezing, I would be more amenable to freezing my eggs  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
6. If the government legalized Elective Oocyte Freezing, I would be interested in freezing my eggs  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
7. If the government encouraged oocyte freezing, I would be more amenable to freezing my eggs  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
8. Social oocytes freezing should be offered to women of all ages  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree
9. Overall, after reading the information leaflet, I would consider freezing my oocytes at some point in time  
 Strongly Agree  Agree  Undecided  Disagree  Strongly Disagree

Appendix E: Likert-Scale Results

	STRONGLY AGREE (5)	AGREE (4)	UNDECIDED (3)	DISAGREE (2)	STRONGLY DISAGREE (4)	AVERAGE
I would consider oocyte freezing if I have no suitable partner yet	12	14	16	5	0	3.702
I would consider oocyte freezing to focus on my career and postpone family planning	9	12	18	8	0	3.468
Even if I had to pay with self-cash, I would still be interested in freezing my eggs	4	12	23	8	1	3.208
If MediShield Life covered oocyte freezing, I would be more amenable to freezing my eggs	21	20	3	3	0	4.255
If there is government subsidy available for egg freezing, I'd be more amenable to freezing my eggs	21	20	4	3	0	4.229
If the government legalized Elective Oocyte Freezing, I would be interested in freezing my eggs	19	16	9	3	0	4.085
If the government encouraged oocyte freezing, I would be more amenable to freezing my eggs	19	14	11	3	0	4.043
Social oocytes freezing should be offered to women of all ages	20	20	3	5	0	4.146
Overall, after reading the information leaflet, I would consider freezing my oocytes at some point in time	12	14	16	6	0	3.667

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