

#Storemysperm: a plan to freeze the clock on falling sperm counts

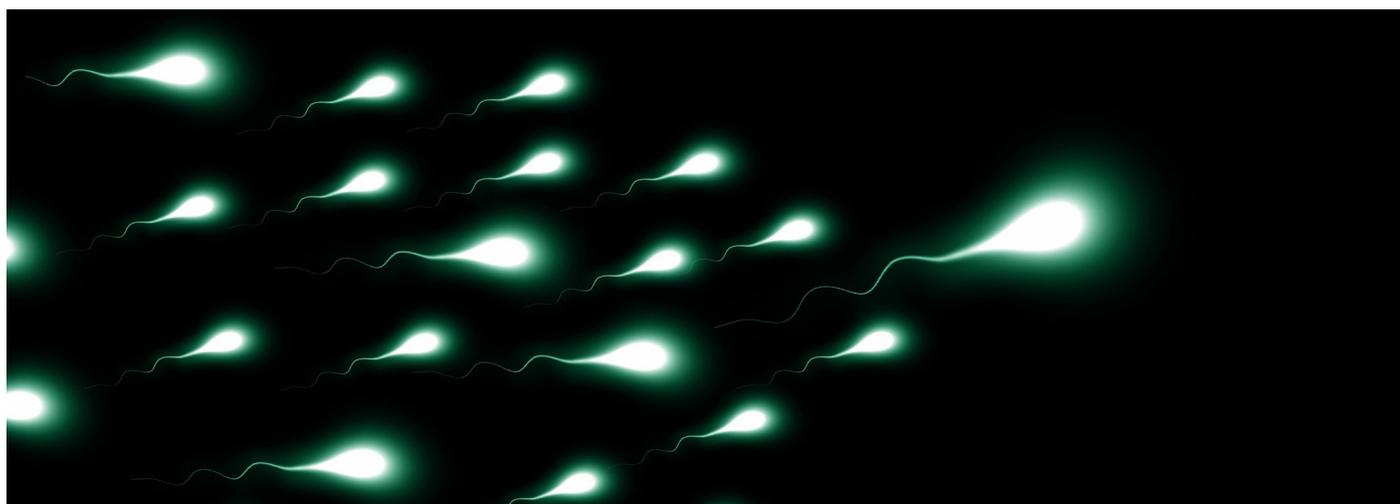
Sarah C. Thomson¹, Scott C Mackenzie², Jinzhang Davy He³

Year 5, Medicine, University of Dundee

¹Email: s.c.y.thomson@dundee.ac.uk

²Email: s.c.mackenzie@dundee.ac.uk

³Email: j.z.he@dundee.ac.uk



Considering recent evidence confirming falling sperm counts over the past 50 years, the future of male fertility seems more uncertain than ever. Despite this potential global health threat, the aetiology of declining sperm counts is still poorly understood. We considered the feasibility of a hypothetical public health sperm cryopreservation programme for young men. Such a programme would ensure the availability of male gametes in the eventuality that sperm counts were to approach or reach zero. A survey was distributed to students to establish willingness and barriers to engage in a sperm cryopreservation programme. Most students were willing to engage with a sperm cryopreservation programme, although ethical, religious and consent-related concerns were identified.

Introduction

The story of declining sperm counts has re-emerged into the public eye once again with conspicuous headlines¹ declaring the end of the world is nigh. Spermageddon: a dystopian future where babies are few and humanity's hopes of survival rely on assisted reproductive technology. This panic was reignited by a meta-regression analysis by Levine et al,² which reported significantly declining sperm counts among unselected western men between 1973 and 2011. Mean sperm concentration (SC) of western men unselected by fertility declined by 1.4% each year during the study period, resulting in an overall mean SC decline of 52.4%. This is stark, given modern medicine offers no therapeutic options to increase SC. The extrapolation of this data suggests that SC could reach zero within 34.1 (23.3–63.6) years and the current WHO reference criteria for subfertility within 23.3 (15.9–43.4) years.³ Yet, this decline seems unique to western men (referring to studies from North America, Europe, Australia and New Zealand), with no similar decline identified among non-western populations.²

Changing semen parameters have been examined by many researchers before, but inconsistencies in sperm-counting techniques

have limited the generalisation and interpretation of available data.^{4–6} The study by Levine et al² is unique in that only studies reporting primary data on human SC obtained using standardised sperm counting methodology were reviewed. This standardisation in counting technique reduces bias, making findings more reliable. It is not unreasonable to anticipate that the aetiology underpinning falling SC could be uncovered in the coming decades, particularly in light of the recent calls to improve our understanding of male reproductive health.^{7,8}

A theory to explain falling SC describes involvement of prenatal insults resulting in testicular dysgenesis syndrome (TDS).⁹ TDS could explain falling SC and the observed rise in cryptorchidism, hypospadias and testicular cancer.⁹ Additionally, environmental pollutants¹⁰ and lifestyle factors, such as obesity,¹¹ may also contribute. Generating functional gametes from stem cells could be a potential solution.¹² With the assumption that SC will continue to decline, what should we do about it, if anything? Pre-emptive action, such as a sperm cryopreservation programme, could be an answer.

Freezing for the future

Efforts to elucidate reasons behind falling sperm counts have not provided a clear solution to this growing problem.⁸ We suggest that sperm cryopreservation amongst young men may be a proactive strategy to ensure availability of male gametes if sperm counts should continue to fall. This strategy would primarily serve as a backup plan to 'buy time' in ensuring sperm availability should developments fail to occur within a reasonable timeframe. We expect that many of the men who may choose to store sperm will not utilise the stored specimens for themselves. It is their sons and grandsons who may be faced with azoospermia and have no other option. Additionally, such a programme may also facilitate sperm donation with appropriate consent and adequate counselling.

Would you freeze your sperm?

A short survey (**Appendix 1**) was distributed to students at the University of Dundee, under local ethical approval, aiming to establish willingness and barriers to engage in such a programme. Participants gave informed consent when partaking in this study. Participants were provided with a short summary of existing research involving falling sperm counts before proceeding to the questionnaire. Medical students of all year groups were targeted via email and social media channels. Full survey responses are available on request from the authors. In summary, most students ($n=85/87$) were aged 18–30 years. Approximately 76% of students ($n=66/87$) expressed willingness to engage in such a cryopreservation programme. Students opting not to engage ($n=21/87$) drew attention to ethical and religious concerns and a disbelief in the seriousness of the problem. Additionally, discomfort with the notion of transgenerational consent and a perceived unnaturalness pervaded throughout responses.

Final thoughts

A population-based sperm cryopreservation programme is probably not feasible at present due to limitations relating to laboratory capacity and availability of trained staff. Other issues requiring consideration include the number of sperm stored per individual, the age at which individuals are invited to store sperm, the current 10-year statutory cryopreservation storage limit¹³ and achieving public engagement. However, these issues do not detract from the potential severity of the situation and fail to consolidate an argument that inaction is an appropriate response. Such a programme may appear drastic, but the need for such measures may become more obvious in coming years. Conversely, declining SC may resolve without intervention, rendering such a programme obsolete. Nonetheless, the next steps could include economic modelling to better understand how such a programme could function. Public health campaigns encouraging and subsidising elective sperm cryopreservation could be considered. We believe the greatest barrier in the implementation of such a programme is financial in nature. Considering a western 'spermageddon' could occur within the next 40 years, we urge that the potential crisis in male reproductive health is acknowledged in the wider scientific community to enable solutions, including cryopreservation, to be actively explored.

Acknowledgements We would like to thank Professor Christopher Barratt and Dr Steven Gellatly (both University of Dundee, Scotland, UK) and Dr Vanessa Kay (Dundee School of Medicine, Scotland, UK) for their guidance.

Copyright This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. To view a copy of the license, visit <https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode>. The copyright of all articles belongs to the author(s), and a citation should be made when any article is quoted, used or referred to in another work. All articles included in the INSPIRE Student Health Sciences Research Journal are written and reviewed by students, and the Editorial Board is composed of students. Thus, this journal has been created for educational purposes and all content is available for reuse by the authors in other formats, including peer-reviewed journals.

References

1. Sturgis I (2018) Spermageddon: why the human race could be infertile in 50 years. Available from: www.telegraph.co.uk/health-fitness/body/spermageddon-human-race-could-infertile-50-years/. Accessed: 27 January 2018.
2. Levine H, Jørgensen N, Martino-Andrade A, et al. Temporal trends in sperm count: a systematic review and meta-regression analysis. *Human reproduction update*, 2017; 23(6):646–659.
3. Cooper TG, Noonan E, Von Eckardstein S, et al. World Health Organization reference values for human semen characteristics. *Human reproduction update*, 2010; 16(3):231–245.
4. Swan SH, Elkin EP, Fenster L. The question of declining sperm density revisited: an analysis of 101 studies published 1934–1996. *Environmental health perspectives*, 2000; 108(10):961–966.
5. Nelson CM, Bunge RG. Semen analysis: evidence for changing parameters of male fertility potential. *Fertility and sterility*, 1974; 25(6):503–507.
6. Carlsen E, Giwercman A, Keiding N, et al. Evidence for decreasing quality of semen during past 50 years. *BMJ*, 1992; 305(6854):609–613.
7. Skakkebaek NE. Sperm counts, testicular cancers, and the environment. *BMJ*, 2017; 359:j4517
8. Barratt CL, De Jonge CJ, Sharpe RM. 'Man up': the importance and strategy for placing male reproductive health centre stage in the political and research agenda. *Human Reproduction*, 2018; 33(4):541–545.
9. Skakkebaek NE, Rajpert-De Meyts E, et al. Male reproductive disorders and fertility trends: influences of environment and genetic susceptibility. *Physiological reviews*, 2015; 96(1):55–97.
10. Carré J, Gatimel N, Moreau J, et al. Does air pollution play a role in infertility?: a systematic review. *Environmental Health*, 2017;16(1):82.
11. Craig JR, Jenkins TG, Carrell DT, et al. Obesity, male infertility, and the sperm epigenome. *Fertility and Sterility*, 2017; 107(4):848–859.
12. Fang F, Li Z, Zhao Q, Li H, et al. Human induced pluripotent stem cells and male infertility: an overview of current progress and perspectives. *Human Reproduction*, 2018; 33(2):188–195.
13. Human Fertilisation & Embryo Authority (2019) Sperm freezing. Available from: www.hfea.gov.uk/treatments/fertility-preservation/sperm-freezing/. Accessed: 28 December 2019.

Appendix 1: Student survey – Would you freeze your sperm?

This survey was carried out under ethical approval (SMED REC 018/18) from the University of Dundee, School of Medicine Research Ethics Committee.

Who are we?

Hello, our names are Davy, Sarah and Scott and we are undergraduate students at the University of Dundee currently undertaking a project as part of BMSc in Human Reproduction. Our supervisor is Professor Christopher Barratt who currently leads the Reproductive Medicine Group at the university.

What is the purpose of this project?

A recently published paper seemed to have confirmed prior suspicions that sperm counts in western men have fallen during the last 40 years. There are concerns about this decline not slowing down or showing any 'levelling off'. There are multiple theories to explain the falling sperm counts, but the exact reasons remain unclear. Sperm cryopreservation for all men between ages 20-24 have been proposed to be a short-term fix to provide time for scientific research to devise a long-term solution. This project wishes to gather opinions about such a public health programme by finding out the potential response rate should such a programme be implemented.

Who should complete this questionnaire?

We are hoping to collect responses only from men as this is more of a pilot and exploratory-type study. We are aware that the decision-making process behind sperm cryopreservation may be complicated at times and may involve multiple people. Hence, we are targeting this questionnaire to only men to keep the analysis straightforward and manageable. Participation in this survey is voluntary.

Question 1

Do you consent to taking part in this questionnaire?

Question 2

The fertility of western men appears to be under threat. A recent published paper seemed to confirm prior suspicions that sperm counts have fallen during the last 40 years (Levine et al. Hum Reprod Update. 2017). Men now have roughly half the number of sperm concentration as compared to 1980 measurements. There are concerns that this decline is not slowing down or stopping when examining data from the last few years. If trends are to continue there may be no sperm within the next 35 years. Although many theories exist, reasons why these sperm counts are falling remain unclear. Freezing the sperm of young men (say aged 20-24) is a possible solution as a short-term fix to ensure the fertility of the next generation. This would buy time until scientific solutions to address the problem become available. If a public health campaign offering sperm freezing for young men was to become available – would you freeze your sperm for your sons and grandsons to use?

Question 3

If you answered 'no' to Question 2, please explain why.

Question 4

What is your age?