NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2024

LIFE SCIENCES: PAPER II

SOURCE MATERIAL BOOKLET FOR QUESTIONS 1, 2 AND 3

SECTION A

QUESTION 1

Read the information below. Use this information, as well as your own knowledge, to answer Question 1 in the question paper.

DAISY PLANT SUCCESS IN THE SUCCULENT KAROO, SOUTH AFRICA

1. The Succulent Karoo's annual flowering display

The Succulent Karoo Biome is home to 3 715 native plant species, with 40,4% being endemic. This biome receives most of its annual rainfall in winter and is known for its annual spring mass-flowering displays, mainly made up of daisy plants that grow each year. These displays attract tourists globally, contributing significantly to the tourism industry.

The mass-flowering display is linked to the arrival of predictable annual winter rainfall in a typically dry, desert region. Daisy seeds benefit from the rainfall, allowing for mass germination followed by a dependable flowering season, occurring from August to late September. These annual flowering-displays transform the Northern and Western Cape into a colourful landscape.

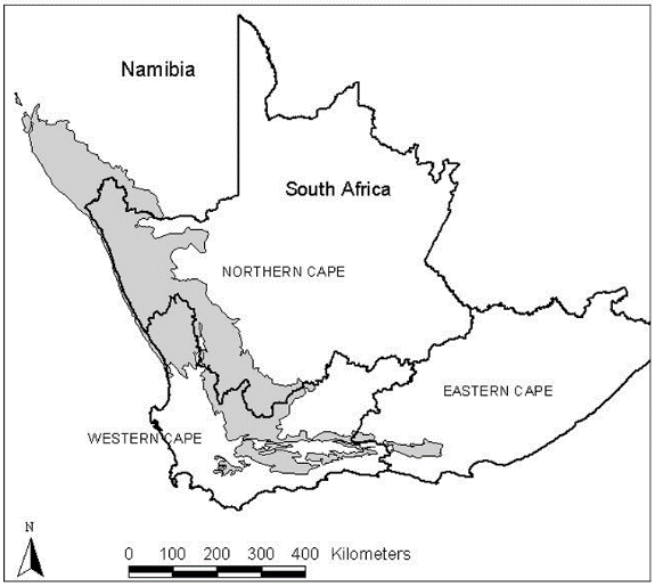

Figure 1.1: The boundary of the Succulent Karoo biome (shaded area) in relation to Namibia and three South African provinces

The daisy family is the largest, most diverse and most successful family of the angiosperms. It is estimated that this family represents around 10% of all flowering species on the planet. Several members of the daisy family have economic importance as food crops. E.g. Artichokes and lettuce are commonly eaten as vegetables, and the edible seeds of sunflowers are used in the production of cooking oils.

2. Daisy display faces climate challenges

The annual bloom of daisies (Figure 1.2) in the Succulent Karoo is facing the impacts of climate change. Research reveals that these wildflowers are blooming earlier each decade. The Succulent Karoo daisies, adapted to survive in dry conditions, rely on a combination of temperature and rainfall changes during winter to trigger their flowering.

As spring arrives earlier, daisies flower earlier, raising concerns as the dormant period for plants shortens, increasing the risk of frost damage.

Figure 1.2: Daisy flowering display

3. Daisy Reproduction

Typical angiosperm flower structures:

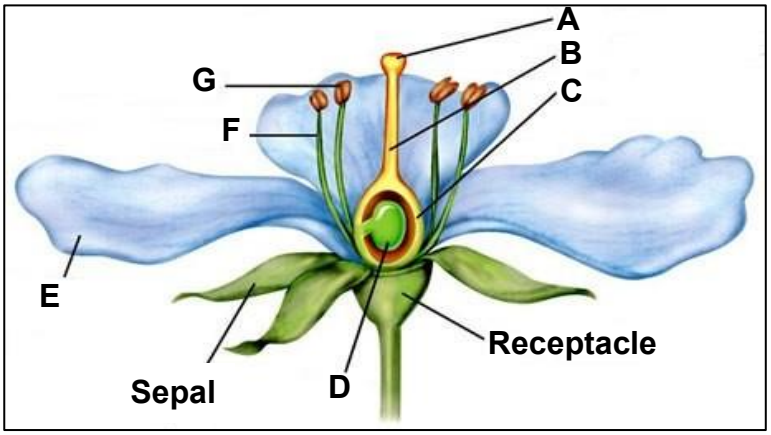

Figure 1.3: Typical angiosperm floral structures

Typical daisy flower structures:

The defining characteristic of daisies is the floral structure. What appears to be one flower is actually a grouping of many smaller flowers. These individual flowers are referred to as florets.

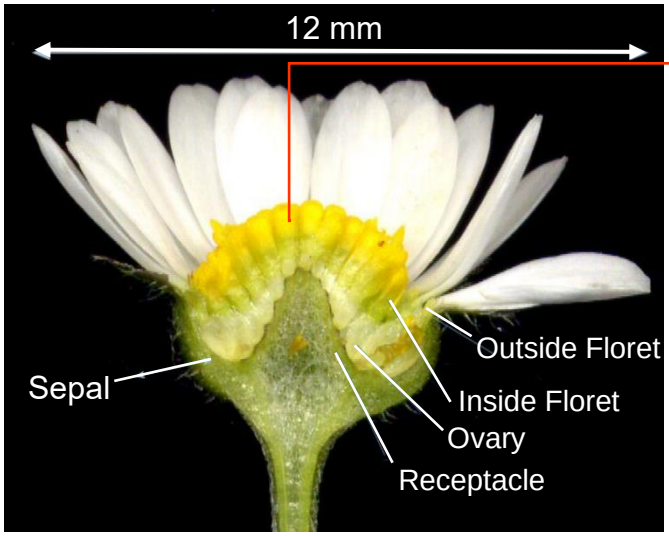

Figure 1.4: Typical daisy floral structures

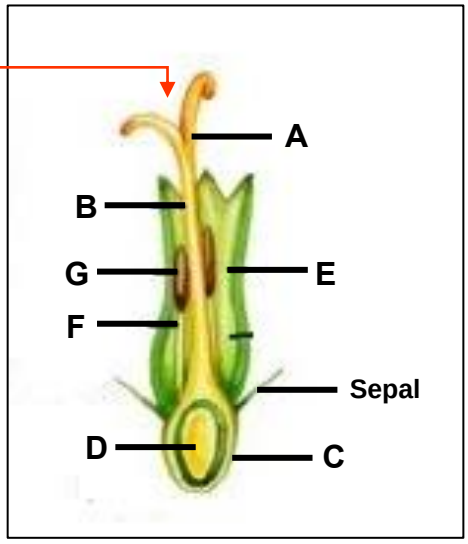

Figure 1.5: Structure of a daisy floret. Letters A–G represent the same structures as letters A–G in Figure 1.3

Daisy flower structural adaptations:

United anthers: Form a tube around the style and developing stigma.
Corolla: The 5 petals of the floret have fused.
Ovary: Contains a single ovule.

Daisy pollination:

The outside florets of daisies do not reproduce and only form big petals that attract pollinators. In inside florets; the male parts develop first and later the female parts ripen (Figure 1.6). This timing difference makes outbreeding (the transfer of pollen between different individuals) possible and reduces the risk of self-pollination.

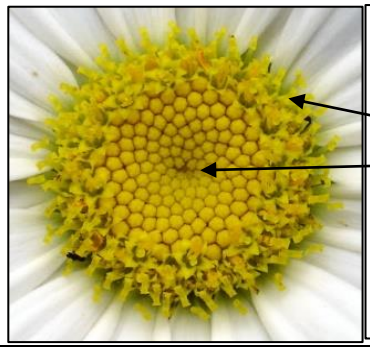

Figure 1.6: Maturation of daisy florets

Polyploidy in daisies:

A single daisy flower can contain as many as 2 000 florets, each with the potential to develop a seed. Each floret produces a single seed. Producing flowers requires a lot of energy usage for plants.

Polyploidy is a widespread phenomenon in angiosperms. It allows for increased mutations, leading to new traits and greater genetic diversity, which can be useful for developing new crops.

In daisies, polyploidy often results in beneficial changes. Some daisy polyploid species produce larger flowers with larger inside florets, more inside florets and/or larger outside florets (Figure 1.7). These new reproductive characteristics help the plants survive in changing environments, find new habitats, or outcompete their original species.

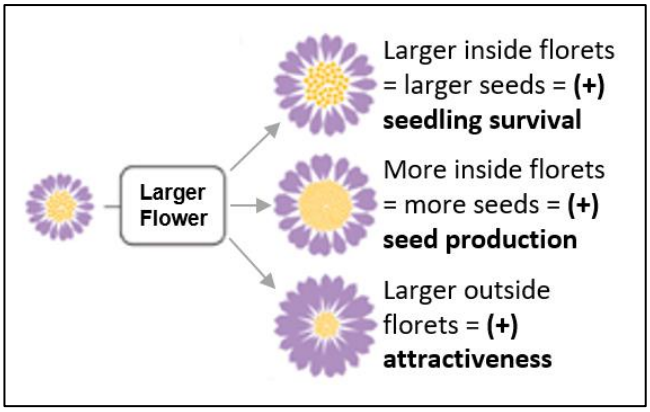

Figure 1.7: Three different effects of polyploidy on daisy flowers

4. Types of Asexual reproduction

4.1 In daisy species, the most common mode of asexual reproduction is a type of asexual reproduction that mimics sexual reproduction. A diploid egg cell is produced without meiosis and directly develops into an embryo without fertilisation. These species can then avoid the energy cost of producing pollen.

4.2 A few daisy species have specialised structures called rhizomes (Figure 1.8) that grow below the ground, like modified roots. These rhizomes produce crowns; which are structures that grow above the ground and develop into new plants.

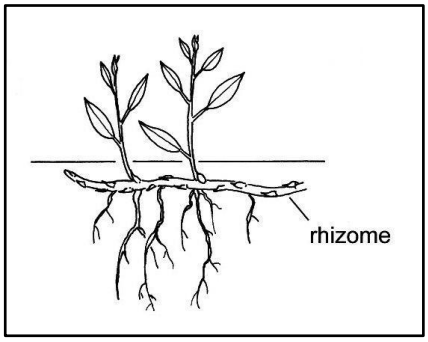

Figure 1.8: Asexual reproduction through rhizomes

Many different species of daisies occur in large numbers in the dry Succulent Karoo landscape because they use more than one way to reproduce.

5. Seed dispersal

Figure 1.9: Dried daisy flower head protecting seeds

After fertilisation and seed formation, the sepals of daisies dry out and fold inwards, protecting and enclosing the seeds. These dried flowering heads (Figure 1.9) can remain on dried out plants for extended periods, forming an aerial seed bank.

In dry environments moisture is the main factor determining seed dispersal. Seeds released during wet periods have an improved chance of germination. Some seeds from the previous flowering season remain in the soil as a seed bank, awaiting the next rainy season.

References:

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[<https://www.nytimes.com/2016/10/06/science/south-africa-flowers-namaqualand.html#:~:text=The%20region's%20predictable%20yearly%20rainfall,winter%20rains%20in%20South%20Africa.>]
[<https://alithographica.tumblr.com/post/183860400841/someone-recently-asked-me-why-flower-anatomy>]
[<https://www.britannica.com/plant/Asteraceae>]
[<https://www.marionwhitehead.co.za/index.php/component/content/article/2-uncategorised/38-the-secret-life-of-plants>]
[<https://www.britannica.com/plant/Asteraceae/Pollination>]
[<https://scholar.sun.ac.za/server/api/core/bitstreams/abd8fa22-7117-4341-ad8f-52a159933af1/content>]
[<https://www.britannica.com/plant/Asteraceae/Fruit-and-seeds>]
[<https://sciencing.com/parts-of-a-daisy-flower-12155734.html>]
[<https://academic.oup.com/aob/article/109/1/19/154024>]

Figure 1.1: The boundary of the Succulent Karoo biome (shaded area) in relation to Namibia and three South African provinces. [adapted from: Rutherford MC 1997. Categorization of Biomes. Pages 91-98. In (eds.) Cowling RM, Richardson DM & Pierce SM. Vegetation of southern Africa. Cambridge University Press, Cambridge.]

Figure 1.2: Daisy flowering display. [adapted from: <https://www.naturetrek.co.uk/tours/the-wild-flowers-of-the-cape-and-namaqualand>]

Figure 1.3: Typical floral structures of angiosperm flowers.
[adapted from: <https://northwestnaturalist.org/category/plantae/angiosperms/; https://edurev.in/t/278576/Important-Diagrams-Sexual-Reproduction-in-Flowering-Plants>]

Figure 1.4: Typical daisy floral structures
[adapted from: <https://www.quora.com/How-do-I-take-care-of-a-daisy-flower>]

Figure 1.5: Structure of a daisy floret.
[adapted from: <https://cronodon.com/BioTech/asteraceae.html>]

Figure 1.6: Maturation of daisy florets.
[adapted from: <https://mathtourist.blogspot.com/2020/04/fermats-natural-spirals.html>]

Figure 1.7: Three different effects of polyploidy on daisy flowers. [adapted from: Fu L et al 2023. Let's pluck the daisy: dissection as a tool to explore the diversity of Asteraceae capitula. *Botanical Journal of the Linnaean Society* 201: 391–399.]

Figure 1.8: Asexual reproduction through rhizomes.
[adapted from: <https://ucjeps.berkeley.edu/eflora/eflora_keys.php?key=58>]

Figure 1.9: Dried daisy flower head protecting seeds.
[adapted from: <https://www.shutterstock.com/image-photo/dead-flower-head-shasta-daisy-all-1775534384>]

QUESTION 2

Read the information below. Use this information, as well as your own knowledge, to answer Question 2 in the question paper.

COMBATING THE 'ELEPHANT PROBLEM' THROUGH REPRODUCTIVE CONTROL

1. The Problem

Throughout much of Africa, elephant numbers have fallen dramatically due to increased ivory poaching pressures and growing urbanisation as the human population expands, leading to competition for space. However, South Africa has the opposite problem: too many elephants.

During the 1900s, poaching nearly wiped out South Africa's elephants. In response, conservationists set up reserves and relocated herds, which thrived as they were protected. Now, their numbers have grown so much that vegetation within these fenced reserves is under threat.

Elephants forage on trees and leaves for nutrition but can damage large trees by stripping bark, breaking branches, or pushing them over (Figure 2.1). This damage makes trees vulnerable to insects and fire, reducing bird, bat, and small mammal diversity, and decreasing available forage for other tree-eating animals like antelope.

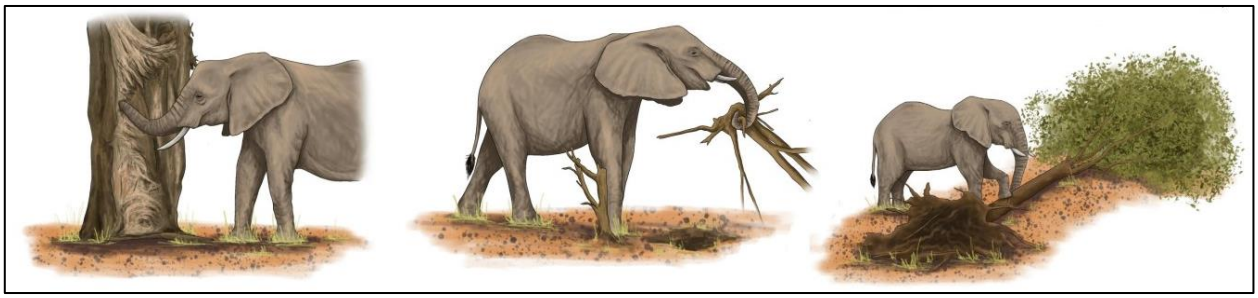

Figure 2:1: Examples of tree damage caused by elephants

Wildlife managers must now figure out how to manage this large population. Traditionally, culling (controlled killing of elephants) was used to reduce their numbers, but this faced public criticism and caused psychological harm to the remaining elephants. Non-lethal methods are now preferred, such as:

- **Contraception** and **sterilisation** to control population growth.
- **Wildlife corridors** to connect different areas, allowing elephants to migrate naturally, reducing their environmental impact by letting them access new areas.

2. Elephant courtship behaviour

Males:

- **Musth in Males:** Males enter a period called musth, characterised by heightened testosterone levels, increased aggression, and active pursuit of females.
- **Chemical Signals:** Bulls produce strong-smelling secretions from glands on the sides of their heads and release chemical signals in their urine.
- **Displays of Strength and Fitness:** To impress females and establish dominance over other males, bulls engage in displays of strength and fitness. This can include pushing over trees, mock battles, and other demonstrations of physical strength.

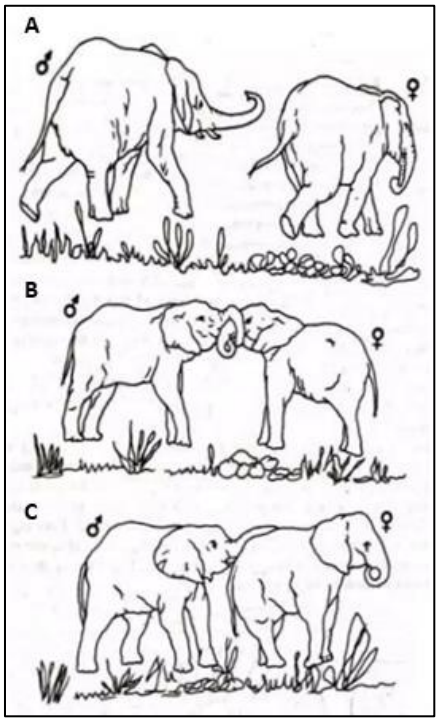

Figure 2.2: Courtship in African elephants: **A** The male chases the female in heat. He raises his trunk to receive her pheromone **B** Male catches female's trunk by his own **C** Lastly he comes back and gently strokes her back if she allows mounting

Females:

- **Female 'heat':** Females exhibit a period when they are sexually receptive and fertile. They signal their readiness to mate through various behaviours and vocalisations, attracting males.
- **Vocalisations:** Female elephants produce low-frequency rumblings that can travel long distances to communicate their reproductive state and attract males.
- **Body Language:** A female indicates her receptiveness by holding her tail to one side, standing still, or moving towards males in a relaxed manner.
- **Mate Choice:** Female elephants are selective about their mating partners. They often prefer males in musth. By choosing a strong, dominant male, the female ensures better genetic quality for her offspring.

3. Reproductive cycles of female African elephants

Elephants do not have a monthly menstrual cycle like humans. Instead, female elephants have periods of fertility about every three months when they can get pregnant. This cycle starts after they reach sexual maturity (around 10–12 years old) and is controlled by changes in their reproductive hormones. Unlike humans, elephants reabsorb their endometrium during their cycle. Female elephants are most fertile, or 'in heat,' for 2 to 6 days around ovulation.

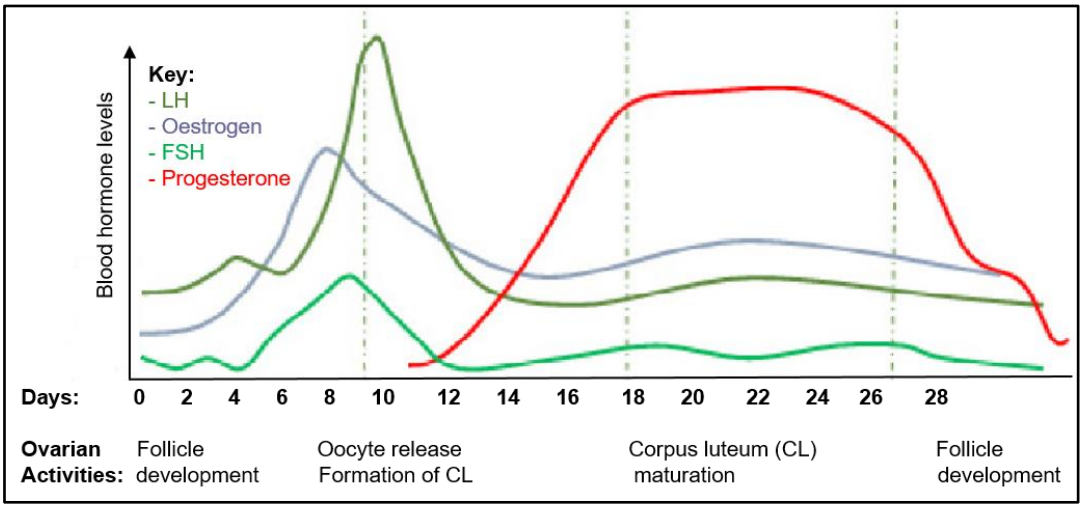

Figure 2.3: Menstrual cycle of the elephant

Elephants are the only mammals to experience two LH surges (Figure 2.3). Both surges are related to elevated oestrogen levels. Each ovary has 2–3 follicles that start to develop after the first surge of the hormone LH. After the second surge of LH, only one dominant (largest) follicle releases an immature ovum and turns into the corpus luteum. The other partially developed follicles also form structures similar to the corpus luteum with this second LH surge and aid with the hormonal maintenance of the longest pregnancy of any living animal; 22 months!

Elephant mothers are fiercely nurturing and protective. They teach their calves everything from how to stand, swim, how to find food, and how to protect themselves. Elephant mothers will nurse their young for 4–6 years.

4. Desired traits for elephant contraceptives

- No health risk for the elephant
- Economically feasible
- Does not affect social group behaviour
- Easy administration
- Little impact on secondary sexual characteristics
- Have long-term anti-fertility effects

5. Immunocontraception in female elephants

Immunocontraception uses the body's immune system, which distinguishes between self and non-self proteins (antigens) to defend against infectious diseases. Immunocontraception is a non-hormonal form of contraception, based on the same principles of disease prevention through vaccination. It stimulates the production of antibodies against some essential element of the reproductive process, thereby preventing pregnancy. One type of immunocontraception is commonly used on female elephants (Figure 2.4).

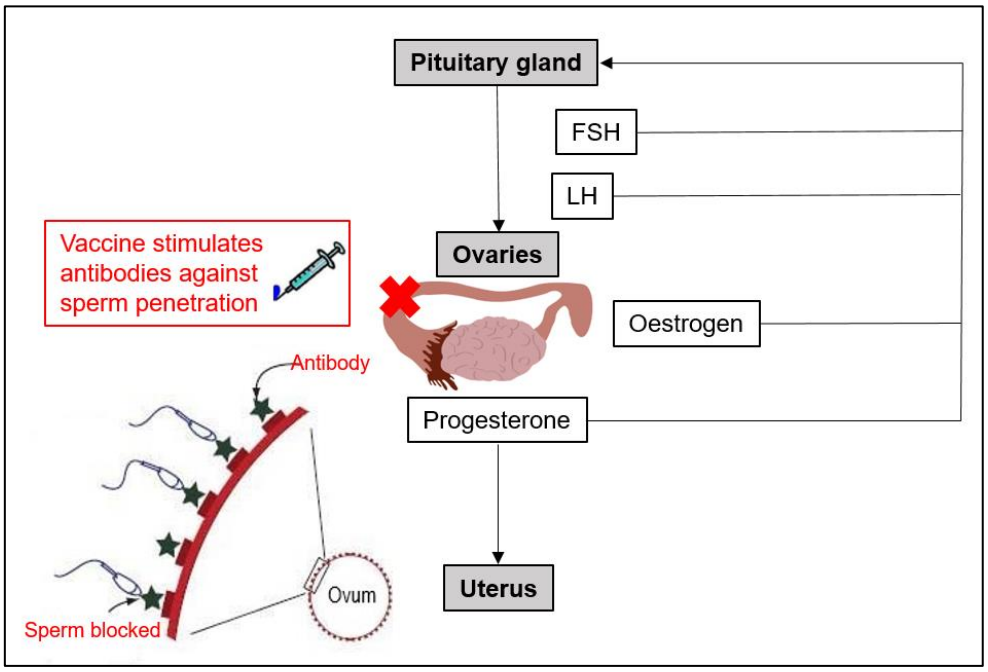

Figure 2.4: The action of immunocontraceptive on female elephant fertility

Success rate of immunocontraception in South African elephant populations:
Immunocontraception has been applied in 8 elephant populations on different game reserves within South Africa. The results of the populations vaccinated are shown below.

Table 2.1: Summary of the effect of the vaccine on contracepted elephants in 8 game reserves in terms of calving data and total populations from Years 1–7 of the investigation

Year	1	2	3	4	5	6	7
No. of Reserves	8	8	8	8	8	8	8
Total population*	364	396	419	427	427	424	424
Cows vaccinated	100	100	50	30	20	20	20
Calves born	32	21	7	0	0	0	0
Calving %★	32.0	21.0	**(A)**	0	0	0	0

***Total Population:** total elephant population for all 8 reserves, including number of deaths during the year and number of calves born the previous year. ★**Calving %:** the percentage of calves born to vaccinated mothers.

6. Surgical vasectomies of elephant bulls

A brief history:

In Feb 2005, Dr Mark Stetter attempted the first vasectomies on two elephant bulls in Mabalingwe Game Reserve. Five more bulls were successfully vasectomised at Songimvelo, Mpumalanga Parks Board during 2007. The full procedure time varied from 2,5 to 3 hours.

Male elephant reproductive system:

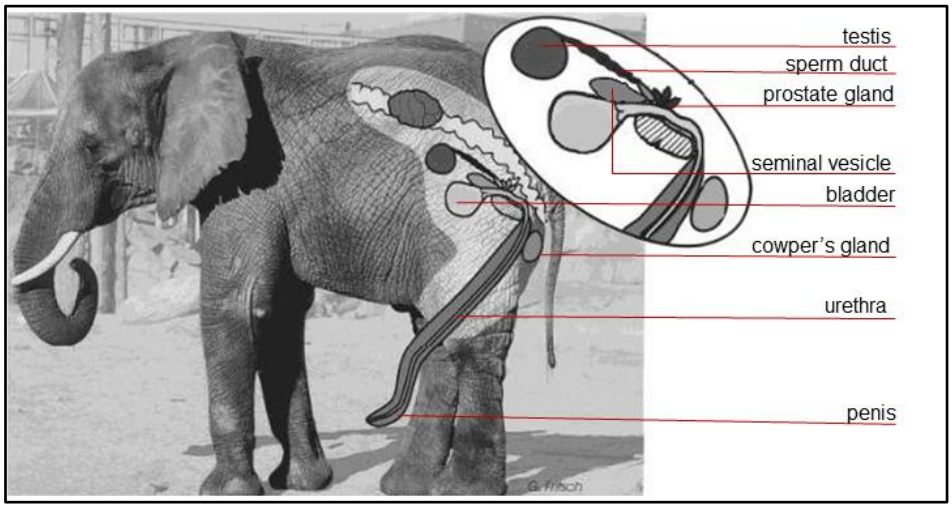

Figure 2.5: Side view of male reproductive system of the African elephant

Impacts of elephant male vasectomies:

If specific males (e.g., dominant or older males) are targeted for vasectomies, there could be a reduction in genetic diversity. This is because fewer males contribute to the gene pool, leading to a higher chance of inbreeding. Male sterilisation through vasectomies do negatively impact female elephant courtship behaviour by:

- Increasing the competition for fertile males.
- If females do not conceive due to mating with vasectomised males, they may remain in heat or return to periods of fertility more frequently.
- Increased behavioural frustration in females leading to increased aggression or altered social hierarchies.

References:

Adapted from:
Bertschinger HA et al 2008. Reproductive control of elephants. pp 257-328. In Mennell K & Scholes R (eds). Elephant Management: A Scientific Assessment of South Africa. Wits University Press, Johannesburg.
Doughty LS et al 2014. The impact of male contraception on dominance hierarchy and herd association patterns of African elephants (*Loxodonta africana*) in a fenced game reserve. *Global Ecology and Conservation* 2:88–96.
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Zitzer HR & Boult VL 2018. Vasectomies of male African elephants as a population management tool: A case study. *Bothalia* 48(2), a2313. https://doi.org/ 10.4102/abc.v48i2.2313
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[<https://www.bbcearth.com/news/elephant-gestation-period-longer-than-any-living-mammal>]
[<https://www.freedomforanimals.org.uk/blog/elephant-mothers>]

Figure 2.1: Examples of tree damage by elephants. [Adapted from: https://issuu.com/savetheelephants/docs/tree_protection_stecoxistencetoolbox]

Figure 2.2: Courtship in African elephant: **A** The male chases the female in heat. He raises his trunk to receive her pheromone. **B** Male catches female's trunk by his own. **C** Lastly he comes back and gently strokes her back if she allows mounting. [Adapted from: Mathur R 2010. Animal Behaviour. Rastogi Publications ISBN 8171337473, 9788171337477]

Figure 2.3: Menstrual cycle of the elephant. [Adapted from Hodges, J.K., 1998. Animal Reproduction Science 53, 3–18. © Elsevier Science, Inc]

Figure 2.4: The action of immunocontraceptive on female elephant fertility. [Adapted from: Rosenfield DA and Pizzutto CS 2018. Wildlife population control – reproductive physiology under the influence of contraceptive methods in mammalian wildlife, with emphasis on immunocontraception: the best choice? A literature review. *Braz. J. Vet. Res. Anim. Sci.* 55(1):1–16. DOI: 10.11606/issn.1678–4456.bjvras.2018.129431]

Figure 2.5: Side view of male reproductive systems of the African elephant. [Adapted from: Hildebrandt TB et al 2000. Ultrasonography of the urogenital tract in elephants (*Loxodonta africana* and *Elephas maximus*): an important tool for assessing male reproductive function. *Zoo Biology* 19:333–345.]

Table 2.1: Summary of the effect of the vaccine on contracepted elephants in 8 game reserves in terms of calving data and total populations from Years 1–7 of the investigation. [Adapted from: <http://www.elephantassessment.co.za/files/08_ch6_Elephant%20Management.pdf>]

SECTION B

QUESTION 3

Read the information below. Refer to this information, as well as your own knowledge, to answer Question 3 in the question paper.

SOURCE A – Maternal age pregnancy trends

Thanks to contraception and the availability of reproductive technologies, couples today have more control over when they start a family. However, waiting to start a family can make it harder to get pregnant due to natural declines in fertility with age and increased risks for pregnancy complications.

Women are most fertile in their 20s, with the highest number of good quality eggs (ova) and the lowest pregnancy risks (Figure 3.1). At age 25, there's about a 20% chance of conceiving after 3 months of trying. Fertility starts to decline around age 32 and speeds up after age 35. By age 35, the chance of conceiving after 3 months drops to about 12%, and at age 40, it's around 7%. Advanced maternal age has been defined as women who are 35 years or older at estimated date of delivery.

Women are born with about 1 million ova in their ovaries, which decrease over time. Older ova have more chromosome problems, raising the risk of birth defects. After age 35, the risks of miscarriage, genetic abnormalities, and pregnancy complications like gestational diabetes increase.

Despite these risks, many women in their 40s can still have healthy pregnancies and babies. However, they face higher chances of caesarean section delivery, premature birth, low birth weight, birth defects, and stillbirth. Additionally, conditions like diabetes and high blood pressure are more common after age 35, contributing to potential pregnancy problems.

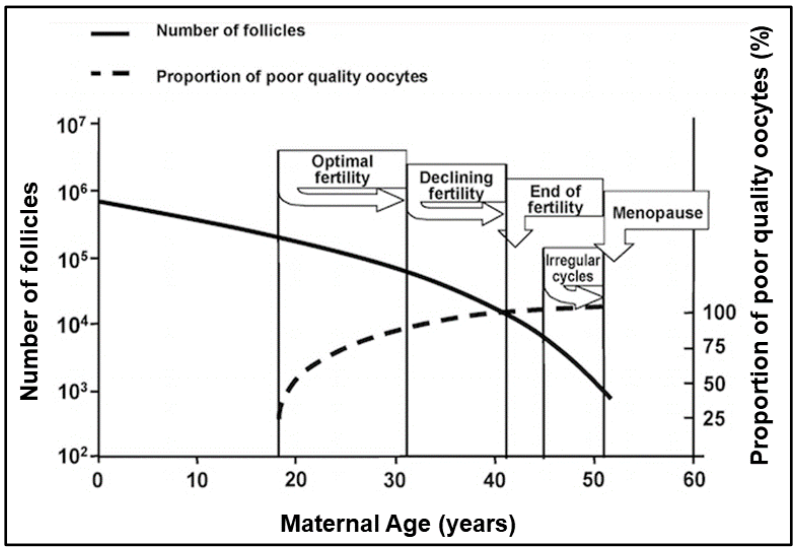


Figure 3.1: Representation of the number of follicles present in the ovaries and the chromosomal quality of oocytes in relation to maternal age [Source: Broekmans FJM et al 2009. Ovarian aging: Mechanisms and clinical consequences. *Endocrine reviews*. 30: 465–93. 10.1210/er.2009–0006]

[Adapted from: What's the best age to get pregnant. By Stephanie Watson Sept 19, 2018. <https://www.healthline.com>]

[*Healthline.com:* is a medical resource that is substantially written by non-expert freelance writers and reviewed by non-expert advisors]

Nowadays, more women are having children later in life, especially in developed countries. Over the past 40 years, birth rates for women aged 35–39 increased by 272%, and for those aged 40–44, by 318%. This trend is due to later marriages, effective contraceptives, and more educational and career opportunities. Delaying childbirth allows women to finish school, start careers, and provide a better environment for their children. However, older mothers face increased risks due to aging reproductive organs, which can lead to complications during pregnancy and childbirth.

Adapted from:
[Duncan GJ et al 2018. Maternal age and child development. *Demography* 55(6): 2229–2255. doi:10.1007/s13524-018-0730-3]
[*Demography* is an interdisciplinary peer-reviewed periodical that publishes articles of general interest to population scientists]
[Hochler H et al 2023. The impact of advanced maternal age on pregnancy outcomes: A retrospective multicentre study. *Journal of Clinical Medicine* 12: 5696. <https://doi.org/10.3390/jcm12175696>]
[*The Journal of Clinical Medicine*: is an international, peer-reviewed, open access journal of clinical medicine]

Dr. Lisa Dunn-Albanese agrees that it has become routine for her to see older women, and that most of them have healthy pregnancies. 'I'm not too worried, I have to admit, about my 30-year-olds,' she says. Age is often a less relevant risk factor than something like an underlying health condition, she adds.

[Adapted from: Why so many women are waiting longer to have kids. By Jamie Ducharme April 10, 2024. <https://time.com>]
[*Time Magazine:* is an American news magazine based in New York City. It was published weekly for nearly a century]

Adolescent pregnancy is a worldwide issue with serious health, social, and economic impacts. Although the global adolescent birth rate has decreased, higher rates are still seen in less developed countries among those with less education and lower income. In these areas many teens still face barriers to accessing contraceptives, increased risks of unintended pregnancies and child marriages.

Each year, about 21 million girls aged 15–19 in developing regions become pregnant, with around 12 million giving birth. Contributing factors include societal pressure to marry and have children, limited education and job opportunities, and the high value placed on motherhood. In 2021, there were around 650 million child brides globally, limiting their control over reproductive choices.

[Adapted from: Adolescent pregnancy. 10 April 2024. World Health Organisation. <https://www.who.int/news-room>]
[*World Health Organisation:* is a specialised agency of the United Nations responsible for international public health]

SOURCE B – Pregnancy complications associated with maternal age

As women age, the risk of chromosome problems in their babies' increases. Research shows that the likelihood of chromosomal abnormalities in miscarriages increases by 6,4% each year as mothers age.

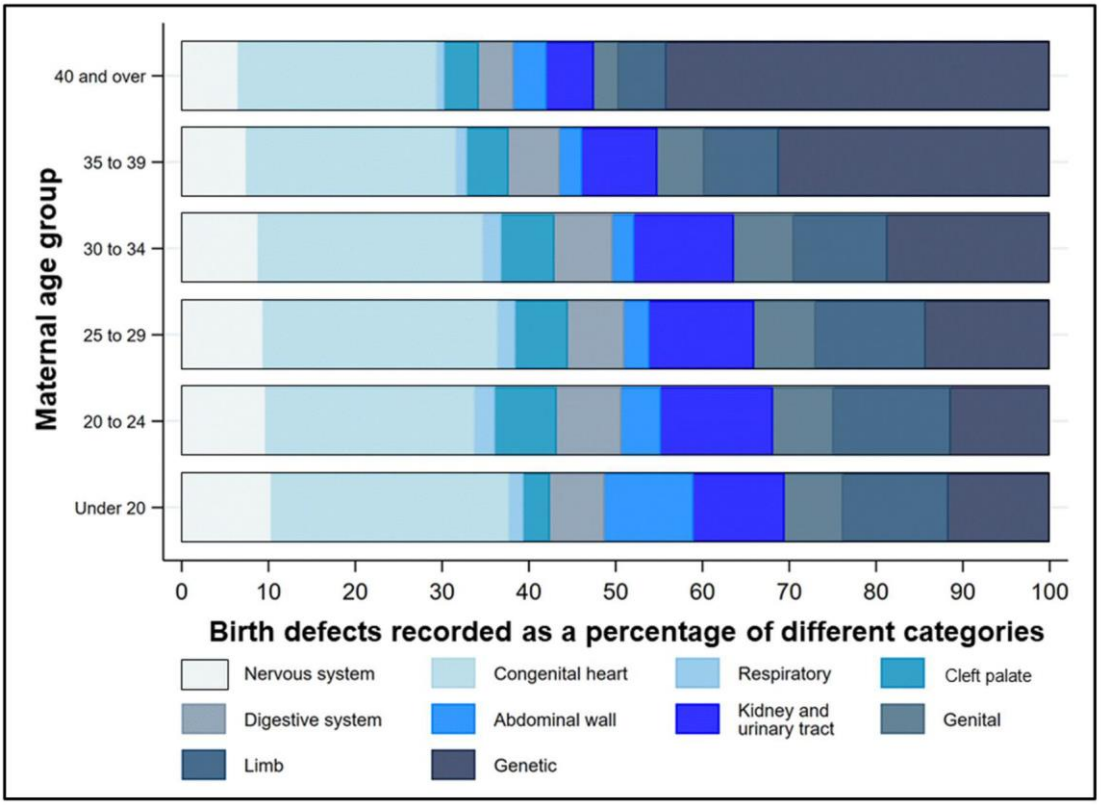


Figure 3.2: Birth defect group by maternal age (percentage values) in England, 2020 [Adapted from: <https://digital.nhs.uk/data-and-information/publications/statistical/ncardrs-congenital-anomaly-statistics-annual-data/ncardrs-congenital-anomaly-statistics-report-2020/maternal-age>]

PREGNANCY COMPLICATION RATES:
(PER 1 000) BY AGE

18–24	25–34	34–44
149,9	190,5	230,7

CHILDBIRTH COMPLICATION RATES:
(PER 1 000) BY AGE

18–24	25–34	34–44
19,4	15,3	19,7

It is important for a pregnancy to reach full term (typically around 39 to 40 weeks) because this allows the baby to fully develop and significantly reduces the risk of complications for both the baby and the mother. Key reasons include:

1. **Lung Development:** The baby's lungs fully mature in the final weeks of pregnancy. Babies born prematurely may have breathing difficulties due to underdeveloped lungs.
2. **Brain Development:** The brain undergoes rapid growth in the last few weeks, and premature babies may face developmental delays or cognitive impairments.
3. **Reduced Risk of Complications:** Premature babies are at higher risk for health issues such as infections, and long-term developmental challenges. For mothers, a premature birth may increase the likelihood of complications like excessive bleeding post-delivery.

4. **Emotional and Psychological Stress:** Mothers of premature babies often experience significant emotional distress due to concerns about the baby's health, prolonged hospital stays, or medical complications associated with prematurity.

For babies, admissions to the neonatal intensive care unit (NICU) increase with the mother's age. NICU admissions increase to 4% occurrence with a maternal age of 40 and peak at 6% occurrence for maternal ages 45–46 years.

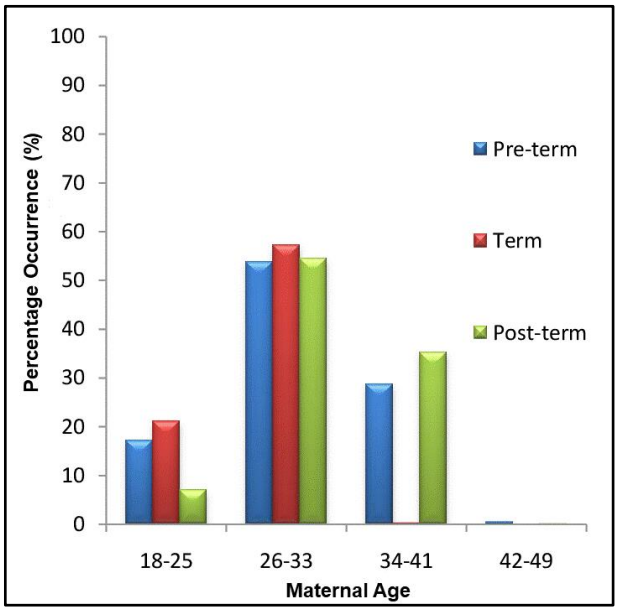


Figure 3.3: Duration of pregnancy for various age groups [Adapted from: Ugorji EA et al 2019. Study of maternal age and pregnancy outcome in a federal tertiary health institution in Delta State, South Nigeria]

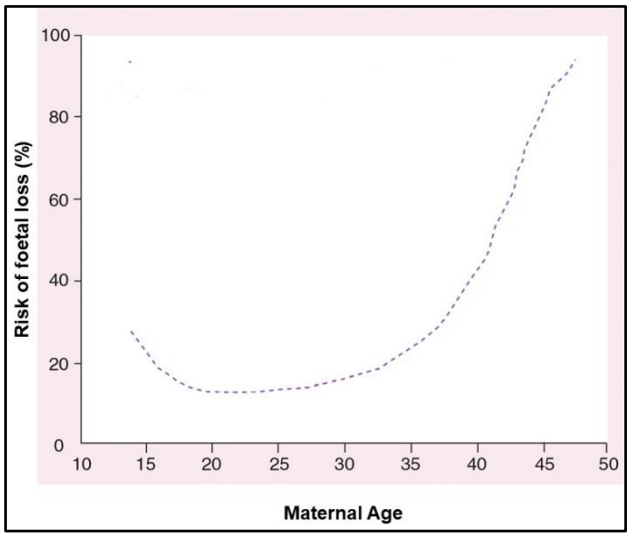
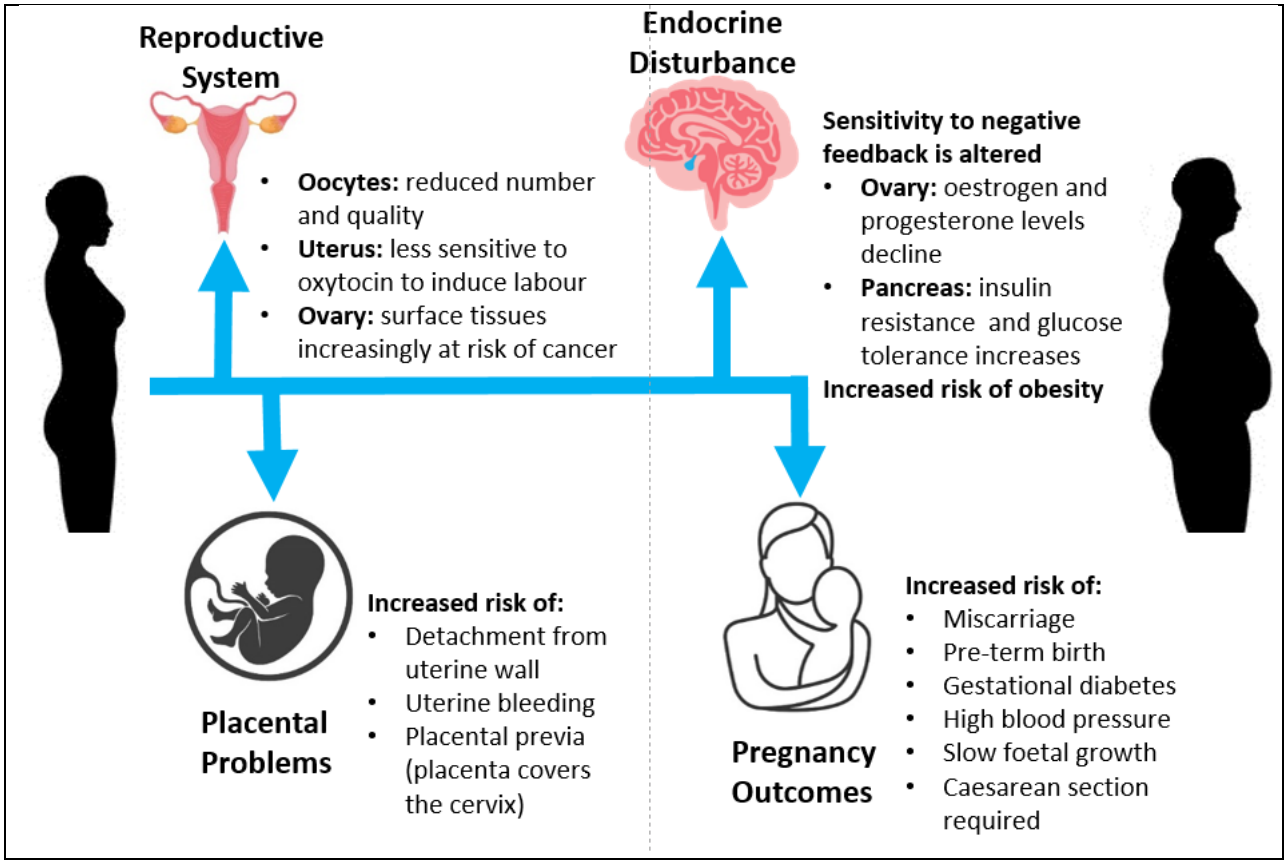


Figure 3.4: Risk of foetal loss from miscarriage and stillbirth [Adapted from: Kausar S and Bewley S 2006. Pregnancy after the age of 40. *Women's Health* 2(6): 839–845. doi:10.2217/17455057.2.6.839]

NOTE (with reference to Figure 3.3):
Pre-term – any early births before 37 weeks of pregnancy
Term – any births between 37 and 41 weeks of pregnancy
Post-term – any births after 41 weeks of pregnancy
Where no bars are recorded, no births were recorded for that category within that maternal age group.

Adapted from:
[Cooke CLM and Davidge ST 2019. Advanced maternal age and the impact on maternal and offspring cardiovascular health. *American Journal of Heart and Circulatory Physiology* 317: H387–H394. doi:10.1152/ajpheart.00045.2019 <www.ajpheart.org>]
[*The American Journal of Heart and Circulatory Physiology*: is a peer-reviewed journal that publishes original investigations, reviews and perspectives on the physiology of the heart, vasculature and lymphatics]
[Chu B et al 2023. The role of advanced parental age in reproductive genetics. *Reproductive Sciences* 30:2907–2919. <https://doi.org/10.1007/s43032-023-01256-2>]
[*Reproductive Sciences:* is a peer-reviewed journal that publishes articles relating to all aspects of Basic Medical Sciences of the reproductive system of humans and animals.]
[<https://www.tommys.org/research/research-topics/pregnancy-complication-research/other-research/does-maternal-age-affect-birth>]
[*Tommy's:* is the largest charity in the UK carrying out research into the causes of miscarriage, stillbirth and premature birth]

SOURCE C – Health risks associated with pregnancy at advanced maternal age



Adapted from:

[National Research Council (US) Panel on Adolescent Pregnancy and Childbearing; Hofferth SL and Hayes CD (eds.) 1987.Risking the Future: Adolescent Sexuality, Pregnancy, and Childbearing, Volume II: Working Papers and Statistical Appendices. Washington (DC): National Academies Press (US). Chapter 8: The children of teen child bearers. <https://www.ncbi.nlm.nih.gov/books/NBK219236/>]

[National Research Council (US): was organised by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of further knowledge and advising the United States federal government]

[Parental age and child development. By Cherry K, September 27, 2020. <https://www.verywellfamily.com>]

[*verywell family* is an online resource for up-to-date information on pregnancy and parenting articles are edited and reviewed by a board of certified physicians and family health experts]

[Ye X et al 2023. The updated understanding of advanced maternal age. *Fundamental Research* <https://doi.org/10.1016/j.fmre.2023.09.013>]

[*Fundamental Research:* open access, peer-reviewed journal, which is supervised by the National Natural Science Foundation of China]

[Chu B et al 2023. The role of advanced parental age in reproductive genetics. *Reproductive Sciences* 30:2907–2919. <https://doi.org/10.1007/s43032-023-01256-2>]

[*Reproductive Sciences:* is a peer-reviewed journal that publishes articles relating to all aspects of Basic Medical Sciences of the reproductive system of humans and animals]

[Zondervan-Zwijnenburg MAJ et al 2020. Parental age and offspring mental health: A multi-cohort population based investigation. *Child Development* 91: 964-982. DOI: 10.1111/cdev.13267]

[*Child Development*: is a peer-reviewed academic journal covering developmental psychology from the foetal period to adolescence]

[Gebreegziabher E et al 2023. Influence of maternal age on birth and infant outcomes at 6 months: a cohort study with quantitative bias analysis. *International Journal of Epidemiology* 52(2): 414–425. <https://doi.org/10.1093/ije/dyac236>]

[*The International Journal of Epidemiology:* is a bimonthly peer-reviewed medical journal covering research in epidemiology]

SOURCE D – Differing parenting styles

Parents utilise their educational background and their personal qualities such as maturity, experience, self-esteem, and emotional well-being to foster their children's development.

Category	Younger Mother	Older Mother
Emotional stability	Often unprepared for the challenges of early motherhood and can suffer from anxiety, stress and depression.	Mental health improves with age. Higher levels of socioemotional skills.
Maturity & Experience	Less life experience and maturity, potentially impacting parenting decisions and coping with challenges.	More mature, patient and have more life experience, contributing to better parenting skills.
Relationships	They may have less established support networks or family resources compared to older mothers.	Likely to have more established, stable relationships or marriages, providing a strong family foundation.
Personal Fulfilment	They may miss out on personal and career development opportunities while focusing on raising children.	More emotionally and mentally prepared for the challenges of parenting.
Education	Young mothers may need to pause or alter their education plans to accommodate parenting responsibilities.	Likely to have higher levels of education, which can positively influence their children's educational outcomes.
Energy Levels	More physical energy to keep up with the demands of young children, and potentially multiple children.	Less physical energy to keep up with young children.
Generation Gap	They may share more common interests and activities with their children, fostering stronger bonds.	Larger generational gap, potentially affecting parenting styles and the understanding of modern parenting practices.
Social Acceptance	Less social stigma (unless they are teenage mothers).	More social judgement for having children later in life.
Financial Stability	Still establishing careers or education, leading to financial challenges.	More stable careers and financial resources.
Time with children	More years to spend with children, and potentially grandchildren.	Less years to spend with children, and less likely to live to see grandchildren.

[Adapted from: Duncan GJ et al 2018. Maternal age and child development. *Demography* 55(6): 2229–2255. doi:10.1007/s13524-018-0730-3]

[*Demography* is an interdisciplinary peer-reviewed periodical that publishes articles of general interest to population scientists]

Experiences of mothers of different ages of having children:

At age 18, Phylicia I.* was already married and pregnant. 'I was extremely emotional and confused as to how to be a mom so young,' she recalls, more than a decade later. 'It's hard to be a parent when you still have a lot of growing up to do yourself.' Phylicia calls her kids 'a gift from God,' but admits that everything would have been easier if she'd waited a few years.

Mandisa M.*, decided to get pregnant right after getting married at age 27, despite the fact that others advised her to wait. 'I truly loved having my daughter at 27. I felt young, confident, full of energy, and ready to be the best mom I could be.'

Meghan E.*, got pregnant when she was 32. It gave her enough time to establish her career and feel like she was on solid ground emotionally. 'There's no doubt that even in the best pregnancies and with the easiest of babies, you still need to cut back on work, even temporarily,' she reflects. 'I put about four solid years into building a name for myself, as well as a solid base of loyal clients, which allowed me to take that step back when needed.'

Amahle N.*, enjoyed having two children at age 35 and 37 because it gave her time to mature and become more financially stable. There was one downside, however: 'I seem to have several years on all the moms around me, which makes me feel somewhat disconnected,' Amahle admits. 'I'd still be invited to the moms' night out kind of things, but there was always something in our conversations that underscored the age gap.'

[Adapted from: Is there a best age to get pregnant? By J Sinrich July 20, 2023. <https://www.parents.com>]
[*Parents.com:* is a well-established website dedicated to providing comprehensive parenting advice]

SOURCE E – Effect of maternal age on lifespan

Parental age can influence both the lifespan (Figure 3.5) and number of children, mainly due to age-related changes in parents' germ cells. Previously, it was believed that gametes were ageless, but now it's known that both eggs (ova) and sperm can deteriorate with parental age. Gametes from older parents are more likely to carry DNA mutations and impaired mitochondrial function, which can make children more frail and potentially accelerate their aging process.

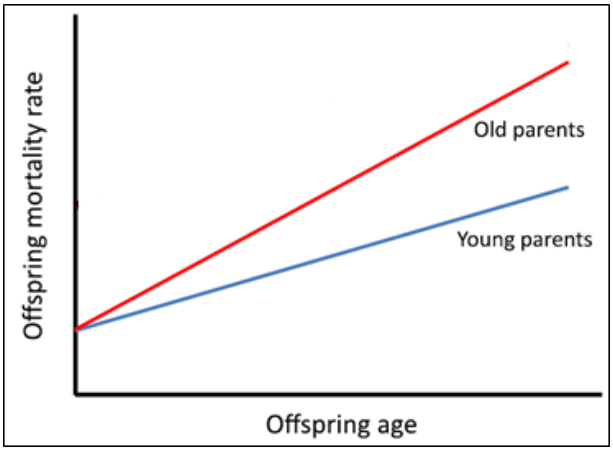


Figure 3.5: The relationship between the mortality rate of offspring and the age of their parents at conception

[Adapted from: Monaghan P et al 2020. Intergenerational transfer of ageing: Parental age and offspring lifespan. *Trends in Ecology and Evolution* 35(10):927–937. <https://doi.org/10.1016/j.tree.2020.07.005>]
[*Trends in Ecology & Evolution* publishes commissioned, peer-reviewed articles in all areas of ecology and evolutionary science]

Women who become mothers in their late teens and early 20s have been found to have higher mortality rates compared to those who become parents later. Additionally, studies indicate that having a first child around age 22 or 23 may have negative implications for health later in life.

[Adapted from: Parental Age and Child Development. By Cherry K, September 27, 2020. <https://www.verywellfamily.com>]
[*verywell family* is an online resource for up-to-date information on pregnancy and parenting Articles are edited and reviewed by a board of certified physicians and family health experts]

SOURCE F – Effect of maternal age on mental health

Children of older parents may face challenges such as dealing with parental frailty or loss at a young age, which can lead to stress and health problems. Research shows that higher maternal age is linked to increased depression, anxiety, and stress symptoms in daughters.

Despite these challenges, studies suggest that offspring of older parents, especially mothers, perform better academically, report better health, and have fewer behavioural issues than children of younger parents.

[Adapted from: Zondervan-Zwijnenburg MAJ et al 2020. Parental age and offspring mental health: A multi-cohort population based investigation. *Child Development* 91: 964–982. DOI: 10.1111/cdev.13267]
[*Child Development*: is a bimonthly peer-reviewed academic journal covering developmental psychology from the foetal period to adolescence]

Parental age has been consistently linked to an increased risk of schizophrenia in children. Both younger and older parents have higher chances of having children with schizophrenia compared to average-aged parents, showing a U-shaped relationship. For older parents, the most accepted explanation is the accumulation of new genetic mutations with age. However, this does not explain the increased risk for children of younger parents.

[Adapted from: Ni G et al 2018. Age at first birth in women is genetically associated with increased risk of schizophrenia. *Scientific Reports* 8: 10168. <https://doi.org/10.1038/s41598-018-28160-z>]
[*Scientific Reports*: is a peer-reviewed open-access scientific mega journal published by Nature Portfolio, covering all areas of the natural sciences]

Early parenthood is associated with increased rates of depression. Research indicates that between 16% and 44% of adolescent mothers' experience mental health disorders. These mental health issues have significant long-term effects on a woman's overall well-being, functioning, and quality of life. Importantly, maternal mental health conditions also have effects on the physical, emotional, and neurological development of newborns and children (Figure 3.6).

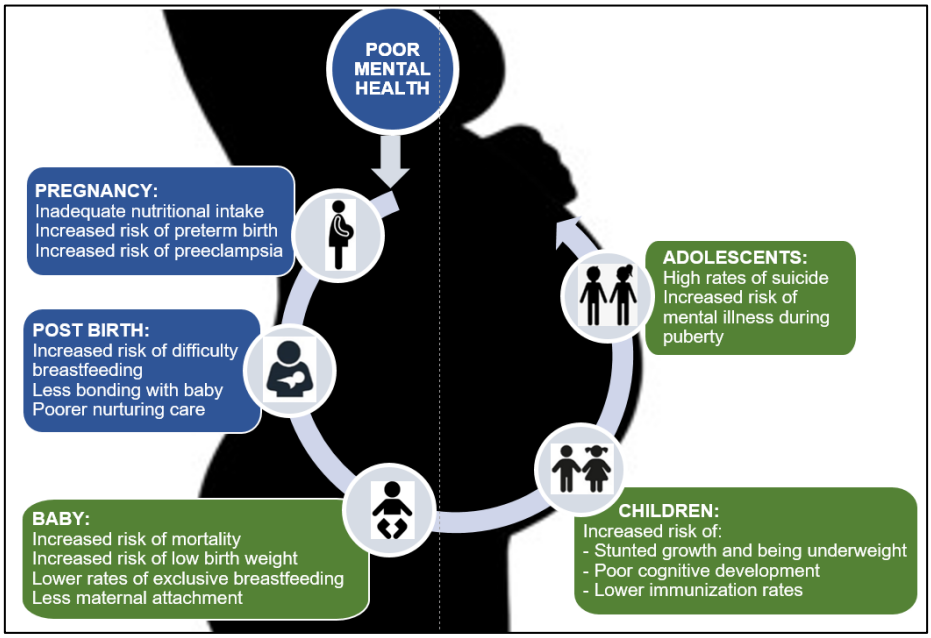


Figure 3.6: The impact of adolescent maternal mental health disorders on the young mother's **(blue)** and their children's **(green)** outcomes

[Adapted from: McNab SE et al 2022. The silent burden: a landscape analysis of common perinatal mental disorders in low- and middle-income countries. *BMC Pregnancy Childbirth* 22: 342 <https://doi.org/10.1186/s12884-022-04589-z>]
[*BMC Pregnancy Childbirth*: is A peer-reviewed, open access journal in pregnancy, childbirth & maternity care]