APPENDIX A

TABLE 1 FACTS ABOUT REPRODUCTION IN THE CAT [1–4].

Female — age at sexual maturity/first oestrus (heat/season)	Range 4–12 months
Male — age at sexual maturity	Range 5–12 months
Oestrous cycle in non-pregnant animals	Every 14–21 days on average (14–19 days where day length is constant)
Duration of oestrus period	2–19 days
Gestation period	Mean = 63 days Range = 58–70 days
Number of young	4–6
First occurrence of oestrous after parturition	7–9 days

Definitions

Oestrus: recurring period of sexual receptivity and fertility in many female mammals; also called a heat/season.

Gestation: the process or period of young developing inside the womb between conception and birth during pregnancy.

Parturition: the action of giving birth to young.

TABLE 2 MEDICAL AND BEHAVIOURAL BENEFITS OF DESEXING [5,6].

Male cats	• Prevention of testicular cancer. • Decreased interest in wandering/roaming to find female mates and, consequently, decreased risk-associated behaviour (for example, less likely to become lost or be involved in a traumatic accident such as being hit by a car). • Reduction of risk of cat fight injuries and related diseases such as felin immunodeficiency virus (FIV). • Reduction in urine spraying.
Female cats	• Prevention of reproductive organ disease such as ovarian cancer and uterine diseases. • Prevention of unwanted/unplanned pregnancies. • Prevention of potentially undesirable 'on heat' behaviours such as restlessness and being highly vocal. • Prevention of mammary cancer.

APPENDIX B

BENEFITS OF DESEXING CATS BEFORE PUBERTY

There are a number of specific benefits relating to surgery and anaesthesia conferred by desexing cats before puberty, including the following:

1 Improved surgical outcomes

The surgery to desex a cat before puberty is faster and easier than in older patients, although gentle handling of delicate paediatric tissues is required [2,7–10]. The speed and ease of desexing pre-pubertal patients is likely due to the physiological differences between kittens and adult cats. For example, a kitten has smaller and more elastic gonadal vessels, relatively large ovaries compared to the size of the kitten (making them easier to identify) and smaller amounts of abdominal and bursal fat. These factors all contribute to the ability to perform the desexing surgery through a smaller incision site, achieve good visualisation and haemostasis and, ultimately, minimise tissue trauma and improve recovery time [2,7,8,10–13].

In addition, pre-pubertal cats will not be in heat or pregnant at the time of desexing. Since an enlarged or friable uterus makes the surgery more difficult, this means spey surgeries in pre-pubertal cats are simpler [9].

The risk of wound infection has been shown to increase with increasing duration of surgery [14] and, consequently, a shorter surgery time (as is associated with desexing cats before puberty) is desirable to reduce the risk of wound infection.

2 Postoperative pain

The degree of surgical trauma affects the degree of postoperative pain [9]. Therefore, the simpler surgery and less tissue trauma when desexing cats before puberty may explain why kittens may have less pain and seem to return to normal behaviour more rapidly after undergoing ovariohysterectomy compared to cats over four months of age when receiving the same pain relief [9,15]. In two studies reporting this finding [9,16], pain was assessed using a simple descriptive scale (SDS), a dynamic and interactive visual scale (DIVAS) and mechanical nociceptive thresholds (MNT). Cats under four months of age had lower DIVAS and SDS than adults ($P < 0.05$), but similar MNT. This was interpreted to mean that kittens had similar wound tenderness, but less affective pain than adults but assessment of pain in cats, and paediatric patients, can be challenging. More research in this area would be valuable, particularly using the more recently validated feline pain scoring systems such as the Feline Grimace Scale [17–19], UNESP-Botucatu multidimensional composite pain scale [20] and the Glasgow Composite Measure Pain Scale feline (CMPS- Feline) [21,22]. Also research focusing on pain in kittens and young cats would be valuable, as pain perception may differ between young and more mature animals [15].

3 Reduced time under anaesthesia and faster recovery

The procedure for desexing cats before puberty is faster than desexing performed at a traditional age [7,8,11]. This results in less time under general anaesthesia for the patient. In addition, anaesthetic recovery and wound healing times are faster. This provides significant animal welfare benefits, including less patient discomfort [7,8].

4 Fewer complications

The incidence of peri-operative complications in cats desexed before puberty is low due to significantly shorter surgical and anaesthetic times [7,8]. Significantly less overall and minor complications have been reported for animals desexed at <12 weeks and 12–23 weeks of age, compared to animals desexed at ≥24 weeks of age [8].

5 Reduced cost

Less anaesthetic agent is required by younger smaller patients, which equates to a reduced cost per patient. Desexing cats before puberty is also associated with a shorter surgical time, and less suture material and other consumables are used. These factors all make desexing cats before puberty a cheaper option for veterinary clinics than desexing at a traditional age [7,23].

6 Elimination of unwanted pregnancies

Desexing cats before puberty eliminates the risk of an unplanned litter (e.g. no risk of an unplanned first oestrus cycle litter in in female cats or the siring of a litter by male cats before the cat is desexed) [7].

7 Reduced risk of mammary neoplasia

Aged queens are seven times more likely to have mammary neoplasia than desexed cats and the greatest reduction in incidence is associated with desexing before the first oestrus [5,24,25]. Mammary neoplasia is a very serious disease in cats as it is almost always malignant adenocarcinoma.

APPENDIX C

RISKS ASSOCIATED WITH DESEXING AT DIFFERENT AGES

1 Short-term risks associated with desexing at different ages

Anaesthesia and surgery

The evidence demonstrates that there is no significant difference in mortality or morbidity (medical problems, signs of disease) associated with desexing cats before puberty compared to desexing at a traditional age if anaesthesia and surgery are performed appropriately [7,8,10–13,26]. However, it has been suggested that a lack of experience with paediatric anaesthesia can contribute to the reluctance on the part of some veterinarians to desex cats before puberty [27,28]. This can be addressed with more training, including the ability to gain experience in paediatric anaesthesia and surgery. As with any anaesthetic and surgical procedure, it is essential to have adequate training and experience and access to appropriate resources and equipment is vital to ensure that the recommended preoperative, operative and postoperative protocols are used.

The following specific considerations associated with paediatric patients should be taken into account when developing and implementing protocols for desexing cats before puberty. Paediatric patients (patients under 16 weeks of age) have:

- a variable ability to metabolise some drugs via the liver's P450 enzyme system [29]. Therefore, appropriate drugs must be used.
- a lower percentage of body fat, a decreased ability to shiver and a larger surface area to volume ratio. Therefore, particular attention to maintenance of body temperature is critical to avoid hypothermia [5,7,29].
- a reduced capacity to raise blood sugar by glycogenolysis or gluconeogenesis due to their relatively low muscle mass and associated less glycogen stores than adult animals. In addition, their immature hepatic function increases the risk of hypoglycaemia. Therefore, steps need to be taken to mitigate the risk of hypoglycaemia [5,7,29,30].

As with all feline patients, it is important to use feline-friendly handling techniques and reduce stress as much as possible [31].

Advances in veterinary anaesthesia have reduced anaesthetic risk in general. Current estimates in the veterinary anaesthesia literature suggest that approximately 0.1–0.2% of apparently healthy cats die of an anaesthetic-related complication [32]. Numerous studies have demonstrated that, provided appropriate measures are in place, there is no increased risk of anaesthetic complications associated with desexing cats before puberty compared to desexing at a traditional age [8,10,12,33,34].

When compared to traditional age desexing, desexing cats before puberty has been shown to have:

- A lower overall complication rate [8,12].
- A similar or lower postoperative wound infection rate [11,35].
- Shorter recovery times from anaesthesia [36].
- Similar or lower morbidity (medical problems, signs of disease) [8,10,11,13].
- Equivalent mortality rates [12,13,33].
- Faster surgical times for both males and females [12].
- No difference in any health issues arising within the first 30 days following adoption [12].

RSPCA shelters in Australia currently desex tens of thousands of cats before puberty every year and perform tens of thousands of early-age desexing (EAD — desexing at 8–12 weeks of age) procedures. The RSPCA's experience with desexing cats before puberty is that the risk of anaesthetic and surgical complications is no different and possibly less than that of traditional age desexing.

Peri-procedure guidelines for desexing cats before puberty

[5,7,11,12,23,26,30,37]

- House littermates together prior to surgery.
- With shelter kittens if possible, perform the surgery onsite/within the shelter, to reduce any stress involved in transporting kittens to an external clinic.
- Minimise pre-surgical fasting: a very small meal of wet food (not dry food) should be fed to kittens two to four hours before surgery, and food should not be withheld for more than four hours before surgery.
- Use appropriate reduced drug doses and careful titration of doses.
- Use modern induction agents with good safety profile and titrate them appropriately to effect.
- Reduce stress by using premedication and gentle feline-friendly handling.
- Use appropriate analgesia.
- Maintain age-appropriate heart and respiratory rates (noting that normal heart and respiratory rates are higher in paediatric patients compared to adults).
- Use endotracheal intubation where indicated (generally not needed for for uncomplicated kitten castrations).
- Use oxygen supplementation and additional inhalant anaesthesia when appropriate.
- Pay careful attention to patient temperature peri-operatively and take steps to prevent hypothermia, such as the following:
  - use appropriate heating pads or hot water bottles throughout general anaesthesia and recovery under careful observation and taking measures to prevent thermal injury
  - keep the environment warm
  - warm all prep solutions
  - do not allow the kitten's coat to become wet
  - avoid excessive clipping and excessive use of alcohol
  - use surgical incisions that are as small as possible
  - if giving any fluids, they (and/or the fluid line during administration) should be warmed to body temperature prior to fluid administration
  - reduce prep, surgical and anaesthesia time as much as possible.
- Use fluid support when indicated. Fluid supplementation is recommended for surgery on patients considered high risk, or when substantial blood loss or prolonged surgery times are anticipated or encountered. If fluids are given, they should be administered following current veterinary medical guidelines for fluid therapy.
- Place intravenous catheters; it is necessary to have the ability to provide IV fluid administration immediately when medically indicated.
- Resume feeding as soon as the kitten is standing and able to effectively swallow after anaesthesia.
- House littermates together in recovery as soon as they can stand.

Infectious disease

Some concerns have been raised that desexing cats before puberty may be associated with an increased incidence of infectious disease, but this is not supported by the available evidence. It is important for veterinarians to select appropriate healthy patients and to adequately weigh the risks and benefits of desexing patients with mild infectious (or non-infectious) medical conditions when selecting patients [30].

Cats desexed younger than a traditional age have been found to be no more likely than those desexed at a traditional age to have any conditions that could be associated with long-term immune suppression [38].

In the shelter context, the length of stay (the period of time the animal is in the shelter's care, from intake to exit) has been clearly identified as a major risk factor for animal illness such as infectious disease [39]. Desexing cats before puberty and as early as possible through EAD, enables shelters to rehome animals more efficiently, which in turn reduces their length of stay and, in this way, may reduce the risk of infectious disease in shelters.

It is important to implement appropriate infectious disease control protocols for all desexing procedures [30]. Effective animal health and infectious disease management significantly minimises the risk but infectious disease transmission is always still a possibility in shelter environments [39]. Practices that minimise risk include: veterinary health assessment and vaccination on entry to the shelter; appropriate and effective use of isolation and quarantine; ensuring animals are in the best physical health possible; minimising stress while in the shelter; efficient rehoming to reduce length of stay; and adequate facility and sanitation protocols [8,39]. To reduce risk of infectious disease, protocols should be arranged so that movement through the shelter and cleaning proceed from the areas housing those animals most susceptible to disease and/or the healthiest animals to those most likely to be the source of contagious disease [39].

In non-shelter contexts such as private practice, where desexing before puberty would be an elective procedure, kittens should ideally be fully vaccinated prior to surgery [13]. Veterinarians can tailor the vaccination protocol to ensure animals have been fully vaccinated before their admission for desexing. For example, for a kitten the process could be to complete their routine course of vaccinations and then desex approximately two weeks after the vaccinations are complete. Therefore, desexing would be performed at approximately 16 weeks of age [40]. There is no evidence that desexing cats before puberty results in an increased risk of infectious disease compared with desexing at a traditional age. Appropriate and routine procedures must be followed to minimise infectious disease risk as with any surgery.

2 Long-term risks associated with desexing at different ages

Numerous controlled prospective studies, retrospective cohort studies, owner surveys and reviews have concluded that desexing cats before puberty is not associated with more long-term risk and that there are no health or behaviour related contraindications when compared to desexing cats at a traditional age [5,38,41–45].

Behaviour

Potential effects on behaviour of the age at which cat are desexed is an important consideration, because problem behaviours can affect the human-cat relationship and are often identified as a reason for the relinquishment of companion animals [46,47]. Unwanted behaviour has also been cited as the main reason for cats being returned to shelters after adoption [48]. It is important to note that behaviour can be influenced by a combination of factors such as genetics (inheritance), life experiences, and the environment. In addition, owner tolerance of unwanted behaviours varies considerably [43,49].

Desexing at any age helps to eliminate or reduce behaviours associated with entire cats that people find objectionable (e.g. scent marking, spraying, fighting, roaming and behaviours associated with oestrus in females, such as calling) [7,50]. There have numerous studies that have investigated whether there is association in the development of problem behaviours in cats with the age at which the cats were desexed. No association has been found between desexing cats before puberty and significant problem behaviours. For example, hunting, fearful behaviour, destructive behaviour, attention seeking, stealing of food, excessive vocalisation, non-play related aggression toward animals and toward humans, house soiling and sexual behaviour all show no association with age at desexing [23,38,43,45,51,52]. As well as the positive effects of desexing (before puberty or at a traditional age) on behaviour, there may actually be some additional behavioural benefits resulting from desexing before puberty, such as a decrease in occurrence of hyperactivity and, in male cats, reduced aggression toward veterinarians, sexual behaviours, occurrence of abscesses and urine spraying [38]. Hiding appeared to be increased in male cats desexed before puberty compared with male cats who underwent desexing at an older age. However, it should be noted that the effects of the environment on behaviour were not factored into these results [38]. It has been reported that many veterinarians in a 2013 survey believed that desexing cats before puberty contributes to them being better pets by improving their behaviour due to prevention of objectionable behaviours [50].

Some anecdotal concerns have been raised about an association between desexing cats before puberty and possible retention of juvenile behaviours but there is no evidence to support this anecdotal concern [23]. A comparison of cats desexed before or after 24 weeks of age and adopted from a shelter showed no difference in owner ratings of urinary or aggressive behaviours, and owners were unaware of the age at which their cat had been desexed [23]. There was also no difference between the groups in retention rates of cats by their adoptive households [23].

The weight of current evidence supports the conclusion that desexing cats before puberty does not have a negative impact on the behaviour of cats, including early development and extending well beyond that into social maturity. Therefore, based on the available evidence it is concluded that there are no behaviour-related contraindications to desexing cats before puberty.

Musculoskeletal development

Desexing cats before puberty has been shown to have similar effects on physical development compared with desexing at a traditional age [45,53].

Desexing at any age is reported to delay physeal (growth-plate) closure in cats. Physeal closure is dependent on gonadal steroids and the reduction of hormones after desexing is the mechanism that causes delay in physeal cartilage maturation and later physeal closure. This extended growth period could result in an increased length of the radius or ulnar bones [5,45,53,54]. Although physeal closure is delayed in desexed cats [45,55], the clinical significance of this is not known [5,6].

Concerns have been raised over whether delayed physeal closure might increase the risk of musculoskeletal problems (e.g. fractures, angular limb deformities, hip dysplasia etc.) and whether desexing cats before puberty might further increase any risk. The available evidence provides conflicting information regarding the clinical relevance of delayed physeal closure and this area needs further investigation [56]. However, the available evidence suggests that there is:

- no clinical relevance of delayed physeal closure [38,42,55], and that it does not appear to render the growth plates more susceptible to injury [51,53].
- no increase in osteoporotic risk (bone loss) [55].
- no increase in risk of fractures or other musculoskeletal problems [6,38,42,51,57,58].

Obesity

Obesity is a multifactorial condition influenced by diet, activity level and genetics. Metabolic rate has been shown to decrease in cats after desexing [13,42,59]. Desexing may predispose toward obesity in cats [6,60,61] but longer term studies have found no association between age at desexing and obesity [38,51].

There is no evidence that desexing cats before puberty increases any risk of obesity [5,26] and appropriate diet and exercise can prevent and/or control obesity. Indeed desexing before puberty may positively affect food intake, which helps cats who are desexed before puberty maintain a more ideal body condition score compared to cats desexed at a traditional age [62]. In one study, cats who were desexed at a traditional age showed a rapid increase in food intake and body weight after desexing [62]. In contrast, although cats desexed before puberty did need to have their food amount restricted earlier (all cats should have their food ration decreased after desexing so these cats' food ration was simply restricted earlier because they were desexed earlier), they did not have the same rapid increase in food intake and body weight after desexing [62]. It was postulated that a more gradual weight gain was enabled due to their growth.

Diabetes

Desexed cats have a two to nine-fold increased risk of developing diabetes mellitus than sexually intact cats [6]. However, there has been no association identified between the age at which a cat is desexed and risk of developing diabetes mellitus. Other risk factors for the development of diabetes mellitus include breed, gender, activity level and increasing age [13,63,64].

Infantile external genitalia

Under-development of external genitalia is often attributed to desexing, particularly if desexing is performed before puberty. However, the clinical significance of these changes is unknown [65]. It has been suggested that under-development of external genitalia may increase the accumulation of penile secretions. It has been postulated that, if this occurred, it might predispose toward balanoposthitis (inflammation of the penis and prepuce) but this has not been observed [26].

In one study it was reported that, subjectively, penile spines were absent in those cats desexed at seven weeks of age, atrophied in those desexed at seven months of age and fully developed in entire cats [45]. The authors suggest that, even if desexing before puberty results in anatomic differences in the penis, these changes do not

appear to lead to an increase in the incidence of feline lower urinary tract disease (FLUTD) or urinary obstruction. The authors concluded that concerns about these conditions should not be used as a reason to delay castration of male cats [45].

Urinary problems

Urethral obstruction

There have been concerns that desexing male cats before puberty may result in decreased diameter of the penile urethra and, consequently, predispose them to urinary obstruction. This has been investigated in a number of studies that have found:

- No significant difference between the pre-prostatic and penile urethral diameter in desexed male cats compared to intact males [65].
- No increase in urethral obstruction for male cats when comparing animals desexed between 8–12 weeks with those desexed between six to eight months of age [42,51].
- No association was found between the age of desexing and the occurrence of urethral obstruction in male cats (age range at desexing: six weeks to 12 months) [38].

Urinary tract disease

The evidence regarding the incidence of urinary tract disease in cats shows:

- No association between the age of desexing and the occurrence of feline lower urinary tract disease [38].
- No increase in feline lower urinary tract disease when comparing male kittens desexed at 8–12 weeks versus six to eight months of age [42].
- Cats desexed at a traditional age appear to be at increased risk for urinary tract problems (including cystitis) compared to those desexed earlier. It has been postulated that desexing cats before puberty may result in some unidentified protective effect on the urinary tract [51].

REFERENCES

[1] Root Kustritz M (2010) Clinical canine and feline Reproduction: Evidence-based answers. Wiley-Blackwell: Ames, Iowa.

[2] Cat Population Control Group (CPCG) (2018) Neutering kittens at four months. A summary of the evidence. Available online: http://www.kind.cats.org.uk/docs/CPCGsummary_of_evidence.pdf (accessed on Aug 20, 2020).

[3] Little SE (2011) Male reproduction. In: The Cat: Clinical medicine and management. Elsevier Saunders, St. Louis MO, USA: 1185–94.

[4] Little SE (2011) Female Reproduction. In: The Cat: Clinical medicine and management. Elsevier Saunders, St. Louis MO, USA: 1195–1227.

[5] Kustritz MVR (2014) Pros, cons, and techniques of pediatric neutering. Veterinary Clinics of North America — Small Animal Practice 44(2):221–33.

[6] Reichler IM (2009) Gonadectomy in cats and dogs: A review of risks and benefits. Reproduction in Domestic Animals 44:29–35.

[7] Bushby PA, Griffin B, Bushby PA (2011) An overview of pediatric spay and neuter benefits and techniques. Available online: https://www.dvm360.com/view/overview-pediatric-spay-and-neuter-benefits-and-techniques (accessed on Aug 20, 2020).

[8] Howe L (1997) Short-term results and complications of prepubertal gonadectomy in cats and dogs. Journal of the American Veterinary Medical Association 211(1):57–62.

[9] Polson S, Taylor PM, Yates D (2014) Effects of age and reproductive status on postoperative pain after routine ovariohysterectomy in cats. Journal of Feline Medicine and Surgery 16(2):170–176.

[10] Porters N, Polis I, Moons C et al (2014) Prepubertal gonadectomy in cats: Different surgical techniques and comparison with gonadectomy at traditional age. Veterinary Record 175(9):223.

[11] Aronsohn MG, Faggella AM (1993) Surgical techniques for neutering 6- to 14-week-old kittens Journal of American Veterinary Medical Association 202(1):53–55.

[12] Porters N, de Rooster H, Moons CP et al (2015) Prepubertal gonadectomy in cats: different injectable anaesthetic combinations and comparison with gonadectomy at traditional age. Journal of Feline Medicine and Surgery 17(6):458–467.

[13] Joyce A, Yates D (2011) Help stop teenage pregnancy. Journal of Feline Medicine and Surgery 13(1):3–10.

[14] Brown DC, Conzemius MG, Shofer F et al (1997) Epidemiologic evaluation of postoperative wound infections in dogs and cats. Journal of the American Veterinary Medical Association 210(9):1302–6.

[15] The Cat Group (2011) Cat neutering practices in the UK. Journal of Feline Medicine and Surgery 13:56–57.

[16] Polson S, Taylor PM, Yates D (2012) Analgesia after feline ovariohysterectomy under midazolam-medetomidine-ketamine anaesthesia with buprenorphine or butorphanol, and carprofen or meloxicam: A prospective, randomised clinical trial. Journal of Feline Medicine and Surgery 14(8):553–559.

[17] Watanabe R, Doodnaught GM, Evangelista MC et al (2020) Inter-rater reliability of the Feline Grimace Scale in cats undergoing dental extractions. Frontiers in Veterinary Science 7:302

[18] Evangelista MC, Benito J, Monteiro BP et al (2020) Clinical applicability of the Feline Grimace Scale: Real-time versus image scoring and the influence of sedation and surgery. PeerJ e8967.

[19] Evangelista MC, Watanabe R, O'Toole E et al (2019) Facial expressions of pain in cats: development of the Feline Grimace Scale. Nature Scientific Reports 9(1):19128.

[20] Brondani J, Mama K, Luna S et al (2013) Validation of the English version of the UNESP-Botucatu multidimensional composite pain scale for assessing postoperative pain in cats. BMC Veterinary Research 9:143.

[21] Calvo G, Holden E, Reid J et al (2014) Development of a behaviour-based measurement tool with defined intervention level for assessing acute pain in cats. Journal of Small Animal Practice 55(1):622–629.

[22] Reid J, Scott EM, Calvo G et al (2017) Definitive Glasgow acute pain scale for cats: Validation and intervention level. Veterinary Record 180(18):449.

[23] Root Kustritz MV (2002) Early spay-neuter: clinical considerations. Clinical Techniques in Small Animal Practice 17(3):124–128.

[24] Hayes HM, Milne KL, Mandell CP (1981) Epidemiological features of feline mammary carcinoma. Veterinary Record 108(22): 476–479.

[25] Overley B, Shofer FS, Goldschmidt MH et al (2005) Association between ovariohysterectomy and feline mammary carcinoma. Journal of Veterinary Internal Medicine 19(4):560–3.

[26] Makin MR, Studdert VP, Webb C et al (2004) Early age desexing of puppies and kittens. In Proceedings of seminars held by the Australian Veterinary Association and the Minister for Agriculture's Animal Welfare Advisory Committee between October and December 2004.

[27] Kustritz MV, Johnston SD, Lieberman LL (2000) Availability of training for prepuberal gonadectomy at North American veterinary colleges. Journal of the American Veterinary Medical Association 216(10):1566–7.

[28] Spain CV, Scarlett JM, Cully SM (2002) When to neuter dogs and cats: A survey of New York State veterinarians' practices and beliefs. Journal of the American Animal Hospital Association 38(5):482–8.

[29] Robertson SA, Feline C, Pascoe P (2018) AAFP Feline Anaesthesia Guidelines. Journal of Feline Medicine and Surgery 20(7):602–634.

[30] Griffin B, Bushby PA, McCobb E et al (2016) The Association of Shelter Veterinarians' 2016 Veterinary Medical Care Guidelines for Spay-Neuter Programs. Journal of the American Veterinary Medical Association 249(2):165–188.

[31] Rodan I, Sundahl E, Carney H et al (2011) AAFP and ISFM Feline-Friendly Handling Guidelines. Journal of Feline Medicine and Surgery 13(5):364–75.

[32] Brodbelt DCD, Pfeiffer DU DU, Young LE et al (2007) Risk factors for anaesthetic-related death in cats: results from the confidential enquiry into perioperative small animal fatalities (CEPSAF). British Journal of Anaesthesia 99(5):617–623.

[33] Levy JK, Bard KM, Tucker SJ et al (2017) Perioperative mortality in cats and dogs undergoing spay or castration at a high-volume clinic. The Veterinary Journal 224:11–15.

[34] Yates D, Yeates J (2014) Prepubertal neutering of cats: Three key points. Veterinary Record 175(9):221–222.

[35] Roberts ML, Beatty JA, Dhand NK et al (2015) Effect of age and surgical approach on perioperative wound complication following ovariohysterectomy in shelter-housed cats in Australia. Journal of Feline Medicine and Surgery Open Reports 1(2):e2055116915613358.

[36] Bruniges N, Taylor PM, Yates D (2016) Injectable anaesthesia for adult cat and kitten castration: effects of medetomidine, dexmedetomidine and atipamezole on recovery. Journal of Feline Medicine and Surgery 18(11):860–867.

[37] Davis H, Jensen T, Johnson A et al (2013) 2013 AAHA/AAFP Fluid Therapy Guidelines for Dogs and Cats. Journal of the American Animal Hospital Association 49:149–159.

[38] Spain CV, Scarlett JM, Houpt KA (2004) Long-term risks and benefits of early-age gonadectomy in cats. Journal of the American Veterinary Medical Association 224(3):372–379.

[39] Newbury S, Blinn MK, Bushby PA et al (2011) Guidelines for Standards of Care in Animal Shelters. The Association of Shelter Veterinarians. Available online: https://www.sheltervet.org/assets/docs/shelter-standards-oct2011-wforward.pdf (accessed on Dec 20, 2020).

[40] The Cat Group (2006) The Cat Group Policy Statement 1: Timing of neutering. Available online: http://www.thecatgroup.org.uk/policy_statements/neut.html (accessed on Sept 2, 2020).

[41] Lord LK, Wittum TE, Scarlett JM (2007) Use of group-randomized trials in pet population research. Preventive Veterinary Medicine 82(3):167–175.

[42] Porters N, Polis I, Moons CPH et al (2015) Relationship between age at gonadectomy and health problems in kittens adopted from shelters. Veterinary Record 176(22):572.

[43] Moons CPH, Valcke A, Verschueren K et al (2018) Effect of early-age gonadectomy on behavior in adopted shelter kittens—The sequel. Journal of Veterinary Behavior 26:43–47.

[44] Olson P, Kustritz M, Johnston S (2001) Early-age neutering of dogs and cats in the United States (a review). Journal of Reproduction and Fertility 57:223–32.

[45] Stubbs W, Bloomberg M, Scruggs S et al (1996) Effects of prepubertal gonadectomy on physical and behavioral development in cats. Journal of the American Veterinary Medical Association 209(11):1864–71.

[46] Salman MD, Hutchison J, Ruch-Gallie R et al (2000) Behavioral reasons for relinquishment of dogs and cats to 12 shelters. Journal of Applied Animal Welfare Science 3(2):93–106.

[47] Zito S, Morton J, Vankan D et al (2016) Reasons people surrender unowned and owned cats to Australian animal shelters and barriers to assuming ownership of unowned cats. Journal of Applied Animal Welfare Science 19(3):303–319.

[48] Casey RA, Vandenbussche S, Bradshaw JWSS et al (2009) Reasons for relinquishment and return of domestic cats (*Felis silvestris catus*) to rescue shelters in the UK. Anthrozoos 2(4)2:347.

[49] Shore ER, Burdsal C, Douglas DK (2008) Pet owners' views of pet behavior problems and willingness to consult experts for assistance. Journal of Applied Animal Welfare Science 11(1):63–73.

[50] Farnworth MJ, Adams NJ, Seksel K et al (2013) Veterinary attitudes towards pre- pubertal gonadectomy of cats: a comparison of samples from New Zealand, Australia and the United Kingdom. New Zealand Veterinary Journal 61(4):226-233.

[51] Howe L, Slater M, Boothe H et al (2000) Long-term outcome of gonadectomy performed at an early age or traditional age in cats. Journal of the American Veterinary Medical Association 217(11):1661–1665.

[52] Porters N, de Rooster H, Verschueren K et al (2014) Development of behavior in adopted shelter kittens after gonadectomy performed at an early age or at a traditional age. Journal of Veterinary Behavior 9(5):196–206.

[53] Root M, Johnston S, Olson PN (1997) The effect of prepuberal and postpuberal gonadectomy on radial physeal closure in male and female domestic cats. Veterinary Radiology and Ultrasound 38(1):42–47.

[54] May C, Bennett D, Downham DY (1989) Delayed physeal closure associated with castration in cats. Journal of Small Animal Practice 32(7):326–328.

[55] Uçmak M, Yilmaz ÖT, Gündüz MC et al (2015) Osteoporotic risk and physeal closure in prepubertal ovariohysterectomized cats. Animal Reproduction Science 161:146–151.

[56] Perry KL, Fordham A, Arthurs GI (2014) Effect of neutering and breed on femoral and tibial physeal closure times in male and female domestic cats. Journal of Feline Medicine and Surgery 16(2):149–156.

[57] Craig LE (2001) Physeal dysplasia with slipped capital femoral epiphysis in 13 cats. Veterinary Pathology 38(1):92–97.

[58] Reed AL, Borostyankoi F, Fischer HR et al (2006) Surgical reduction and stabilization for repair of femoral capital physeal fractures in cats: 13 cases (1998–2002). Journal of the American Veterinary Medical Association 224(9):1478–1482.

[59] Fettman MJ, Stanton CA, Banks LL et al (1997) Effects of neutering on body weight, metabolic rate and glucose tolerance of domestic cats. Research in Veterinary Science 62(2):131–136.

[60] Courcier EA, Mellor DJ, Pendlebury E et al (2012) An investigation into the epidemiology of feline obesity in Great Britain: Results of a cross-sectional study of 47 companion animal practises. Veterinary Record 171(22):560.

[61] McGreevy P, Thomson P, Pride C et al (2008) Overweight or obese cats presented to Australian veterinary practices: risk factors and prevalence. Australian Veterinary Practitioner 38(3):98–107.

[62] Allaway D, Gilham M, Colyer A et al (2017) The impact of time of neutering on weight gain and energy intake in female kittens. Journal of Nutritional Science 6:e9.

[63] Sallander M, Eliasson J, Hedhammar A (2012) Prevalence and risk factors for the development of diabetes mellitus in Swedish cats. Acta Veterinaria Scandinavica 54(1):61.

[64] Öhlund M, Egenvall A, Fall T et al (2017) Environmental risk factors for Diabetes Mellitus in cats. Journal of Veterinary Internal Medicine 31(1):29–35.

[65] Root MV, Johnston SD, Johnston GR et al (1996) The effect of prepuberal and postpuberal gonadectomy on penile extrusion and urethral diameter in the domestic cat. Veterinary Radiology and Ultrasound 37(5):363–366.