UNIVERSITI PUTRA MALAYSIA

PREVALENCE OF RESPIRATORY DISEASES IN THOROUGHBREDS RACING IN PERAK TURF CLUB, AND THEIR ASSOCIATION WITH PERFORMANCE UPON SURGICAL CORRECTION

NUR AISYAH BINTI RIDZUAN

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NUR AISYAH BINTI RIDZUAN

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CERTIFICATION

It is hereby certified that we have read this project paper entitled "Prevalence of Respiratory Diseases in Thoroughbreds Racing in Perak Turf Club, and their Association with Performance upon Surgical Correction", by Nur Aisyah binti Ridzuan. In our opinion, it is satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirement for the course VPD 4999 – Final Year Project.

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DEDICATION

This project paper is dedicated to my dear parents,

Dr Ridzuan Hussin & Uztazah Asmahan Mokhtar

The ones I would give my life and soul to

Siblings,

Nur Rafiqah, Nur Ashiqin, Nur Anisah, Rashdan & Ar-Razi,

For being there come hell or high water

My two little balls of fur,

Ibnu & Agnes

&

To all equine enthusiasts all over the world.

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Deepest gratitude, appreciation and million thanks, first and foremost to my project supervisor, Dr Noraniza Mohd Adzahan, for the time, wisdom, expertise and guidance presented to me in any way possible in order to make this project a success and a reality. Although we went through ups and downs, you still encouraged us to not falter or stumble our way.

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LIST OF ABBREVIATIONS

CAD	*Crico-arytenoideus dorsalis*
CI	Confidence interval
DDSP	Dorsal displacement of soft palate
df	Degree of freedom
EIPH	Exercise-induced pulmonary haemorrhage
et al.	*et alia*
H_o	Null hypothesis
Hα	Alternative hypothesis
IAD	Inflammatory airway disease
Mdn	Median
MRA	Malaysian Racing Association
MYR	Malaysian Ringgit
Nd:YAG	Neodymium:yttrium aluminium garnet
p	P value
r	Effect size
RAO	Recurrent airway obstruction
RLN	Recurrent laryngeal neuropathy
RSQ	Risk-screening questionnaire
SPSS	Statistical Package for the Social Science
STI	Syndrome of tracheal inflammation
TSP	Thermocautery of soft palate
U	Difference between two total ranks
URT	Upper respiratory tract
x^2	Chi-square value
Z	z-score or standard score

ABSTRAK

Abstrak daripada kertas projek yang dikemukan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan kursus VPD 4999 – Projek Ilmiah Tahun Akhir.

PREVALENS PENYAKIT RESPIRATORI DI KALANGAN BAKA THOROUGHBRED YANG BERLUMBA DI PERAK TURF CLUB, DAN KAITANNYA DENGAN PRESTASI PERLUMBAAN SELEPAS SURGERI

oleh

Nur Aisyah binti Ridzuan

2016

Penyelia: Dr Noraniza binti Mohd Adzahan

Di kalangan atlet ekuin penyakit pernafasan yang melibatkan samada saluran pernafasan atas mahupun bawah ataupun kedua-duanya sekali adalah perkara biasa dan telahpun dikenalpasti sebagai salah satu penyebab penting berlakunya penurunan prestasi dikalangan atlet kuda. Prevalens bagi penyakit saluran pernafasan bahagian bawah adalah tinggi dalam kalangan atlet ekuin, namun prevalens penyakit saluran pernafasan bahagian atas adalah lebih sukar untuk dikenalpasti memandangkan penyakit ini tidak dapat dikesan ketika pemeriksaan semasa rehat. Kajian ini tertumpu kepada prevalens penyakit pernafasan dalam kalangan baka Thoroughbred yang berlumba di Perak Turf Club diantara tahun 2011 hingga 2015, dan bagaimana penyakit ini akan mengganggu prestasi perlumbaan. Prestasi kuda lumba akan dibandingkan menggunakan *cross-sectional study* di antara kuda yang melalui surgeri dan mereka yang tidak melalui surgeri. Penyakit pernafasan yang mendapat rekod kes tertinggi adalah *exercise induced pulmonary haemorrhage* (EIPH) Gred 1 ataupun kesukaran bernafas (38.2 %), diikuti EIPH Gred 2 (30.2 %), *recurrent airway obstruction* (RAO) dengan 17.6 %, *epiglottic entrapment* dan lain-lain pada 4.0 % dan 3.0 % masing

masing untuk *dorsal displacement of soft palate* (DDSP) dan pernafasan berbunyi. Tidak terdapat kesinambungan yang signifikan di antara prestasi lumba selepas surgery, dimana kesimpulannnya boleh dikatakan bahawa pembetulan surgery tidak menjamin peningkatan di kalangan prestasi ekuin.

Kata kunci: prevalens; penyakit pernafasan; prestasi selepas surgeri

ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfilment of the course VPD 4999 – Final Year Project.

PREVALENCE OF RESPIRATORY DISEASES IN THOROUGHBREDS RACING IN PERAK TURF CLUB, AND THEIR ASSOCIATION WITH PERFORMANCE UPON SURGICAL CORRECTION

by

Nur Aisyah binti Ridzuan

2016

Supervisor: Dr. Noraniza binti Mohd Adzahan

In equine athletes, respiratory diseases affecting either the upper or lower airways or both are common and they have been identified as an important cause of poor performance in horses. The prevalence of lower airway diseases is high in equine athletes, but the prevalence of upper airways disorders is difficult to be determined since these conditions are not necessarily evident during examination at rest. This study focuses mainly on the prevalence of respiratory diseases in Thoroughbreds racing in Perak Turf Club between year 2011 to 2015, and how they impair race performance. The horses' racing performance is compared using cross-sectional study between those that underwent surgery and those without surgical correction. Respiratory diseases with the highest case recorded was exercise induced pulmonary haemorrhage (EIPH) Grade 1 or respiratory distress (38.2%), followed by EIPH Grade 2 (30.2 %), recurrent airway obstruction (RAO) with 17.6 %, epiglottic entrapment and other conditions with 4.0 % respectively and 3.0 % for both dorsal displacement of soft palate (DDSP) and respiratory noises. There is no significant

association between racing performance following surgery, in which it can be concluded that surgical corrections does not assure improvement in equine performance.

Keywords: prevalence; respiratory diseases; performance after surgical correction

1.0 INTRODUCTION

Athletic animals, particularly the horse have the unique ability to increase its oxygen uptake by a factor of 60 during heavy exercise achievable by the physiological adaptation of all oxygen chain links. Ventilation will then be increased by a factor of 30. However, since horses are obligate nasal breathers, this hyperpnoea necessitates high transmural pressure changes thus causing the dynamic collapse of the airways (Art & Lekeux, 2005). This is common in equine athletes as such it affects not only the upper or lower airways, but sometimes both. As a consequence, even mild occurrence of any respiratory disease, has the potential to impair gas exchange further through the limitation of diffusion or ventilation, which causes decrease in performance. The impact of the disease not only will be dependent on the nature and severity of the disease but also on the equestrian discipline performed (Erck-Westergren *et al.,* 2013).

Based on a simulated model of the normal equine upper airways, it shows that during inhalation, the most negative pressures and highest airflow turbulence occur at the floor of the rostral aspect of the nasopharynx and within the pharynx. That is why these are the areas where dynamic airway collapse commonly occurs (Rakesh *et al.,* 2008). The increase in airway resistance will lead to an increase in respiratory workload, and where airflow is reduced the resulting hypoventilation may lead to decreased oxygen consumption, increased blood lactate concentration and exacerbation of arterial hypoxemia and hypercapnia (Erck-Westergren *et al.,* 2013).

Moreover, in a study performed by Van Erck (2011), it has been found that poll flexion and factors relating to the bit and bridle, may be implicated in the development of upper respiratory tract (URT) collapse. Fatigue of the respiratory musculature may also play a role, thus the type of exercise performed will have an impact on the ability to make a definitive diagnosis of dynamic URT collapse (Allen & Franklin, 2010).

The objectives of this study are:

i. To determine the prevalence of respiratory diseases in Thoroughbreds racing in Perak Turf Club between year 2011 to 2015.

ii. To describe the prevalence of selected respiratory diseases and their association with performance in Thoroughbreds racing in Perak Turf Club between years 2011 to 2015.

iii. To compare racing performance of Thoroughbreds racing in Perak Turf Club with or without surgical correction between year 2011 to 2015.

2.0 LITERATURE REVIEW

2.1 Upper Airway Disorders

The true prevalence of upper airway is difficult to ascertain since most of the conditions are dynamic in nature thus they are not evident upon resting examination (Erck-Westergren *et al.,* 2013). However, retrospective analysis of sport horses presented for poor performance identified disorders in 54 of 77 (70 %) sport horses. Recurrent laryngeal neuropathy (RLN) or laryngeal hemiplegia was identified in 40 % of these horses. Meanwhile, dorsal displacement of soft palate (DDSP) was identified in 11 %, and only 30 % was identified for pharyngeal collapse (Davidson & Martin, 2003). On the other hand, in a study performed by Brown *et al.* (2005), among 744 horses that had undergone endoscopic examination, 7 of the horses had epiglottic entrapment which gives a prevalence of 0.9 %, 2 had laryngeal hemiplegia with prevalence of 0.3 % and 4 had dorsal displacement of soft palate (DDSP) with a prevalence of 0.5 %. Durando *et al.* (2002) also reported that Thoroughbreds are more likely to be affected by upper airway disorders than other breeds.

2.1.1 Recurrent Laryngeal Neuropathy (RLN)

Recurrent laryngeal neuropathy (RLN or idiopathic laryngeal hemiplegia) is a common cause of abnormal respiratory noise and poor performance in athletic horses. The prevalence of the disease varies according to diagnostic criterion and type of horse whereby in Thoroughbreds it is estimated to be 0.3-3 % (Compostella *et al.,* 2012). This disease typically affects the left recurrent laryngeal nerve resulting in predominantly neurogenic atrophy of the intrinsic laryngeal musculature (Figure II), *crico-arytenoideus dorsalis* (CAD)

(Cramp & Barakzai, 2012). In exercising horses, the dynamic collapse of the affected arytenoid cartilage during inspiration causes inspiratory upper airway obstruction (Derksen, 2003) of the *rima glottis* thus turbulent airflow is increased. Hence, the goal of the surgery is to eliminate or reduce respiratory noise and/or improve athletic performance in affected individuals (Cramp & Barakzai, 2012).

A number of surgical treatments for RLN have been described which includes prosthetic laryngoplasty, ventriculectomy, ventriculocordectomy, laser ventriculectomy, partial, total and subtotal arytenoidectomy, laryngeal reinnervation and electrical pacing of laryngeal muscles (Erck-Westergren *et al.,* 2013). Prosthetic laryngoplasty remains the most commonly used surgical procedure in athletic horses (Strand *et al.,* 2000) in which airway obstruction and exercise intolerance are the primary concern (Erck-Westergren *et al.,* 2013). However, only ventriculocordectomy will be of concern since it is the only surgical correction been performed with regards to this study. Ventriculocordectomy comprises of ventriculectomy or sacculectomy, removal of the laryngeal saccule, (Derksen, 2003) plus excision of the vocal cord (Cramp & Barakzai, 2012). Experimental data from horses undergoing bilateral ventriculocordectomy showed that this procedure significantly reduced both upper airway sounds and upper airway obstruction 90 days following surgery (Brown *et al.,* 2003). Data from experimental horses undergoing unilateral laser-assisted ventriculocordectomy also showed this procedure to significantly reduce RLN-associated airway obstruction by 60 days after surgery and also to reduce inspiratory noise though not as effective as bilateral ventriculocordectomy (Robinson *et al.,* 2006). Therefore, unilateral left-sided or bilateral ventriculocordectomy are recommended to treat any grade of RLN in non-performance hoses or for low resting grades of RLN in performing horses (Cramp & Barakzai, 2012).

2.1.2 Dorsal Displacement of Soft Palate (DDSP)

Dorsal displacement of the soft palate (DDSP) is the most common forms of nasopharyngeal collapse described in racehorses and other horses undergoing strenuous exercise (Erck-Westergren *et al.,* 2013). The underlying aetiology of this condition is poorly understood and many theories exist to explain the aetiology of this condition, which is probably multifactorial (Figure III). One of the possible causes is a neuromuscular dysfunction of the structures controlling the position of the soft palate, which may occur due to inflammation and/or infection of the upper airway (Courouce-Malblanc *et. al.,* 2010). Minimal obstruction will be seen during inspiration as the upper airway inspiratory pressure maintains the soft palate closely to the dorsal aspect of the epiglottis. During expiration however, since a proportion of the exhaled air is directed ventral to the displaced palate and into the oral cavity, some horses are reported to exhibit 'fluttering' of the cheeks during exhalation (Barakzai & Hawkes, 2010). Typically, the horse is said to be 'choking down' and performance is reduced markedly near the end of athletic activity (Hogan *et al.,* 2002) due to decreased ventilation as a result of reduced minute ventilation, tidal volume as well as oxygen consumption (Franklin *et al.,* 2002).

Surgical treatments to be considered can be divided into extrinsic procedures (eg. strap muscle resection), which aims at preventing caudal retraction of the larynx, intrinsic procedures (eg. staphylectomy, epiglottic augmentation, rostral palatoplasty, thermal or surgical and caudal palatoplasty) which aims at stiffening the palate and/or the epiglottic cartilage, or both extrinsic and intrinsic procedures (Woodie *et al.,* 2005). With regards to this study, thermocautery, an intrinsic corrective surgery procedure is the surgical correction of interest. Thermocautery of the soft palate (TSP) or thermal palatoplasty is the most common treatment of DDSP, either alone or with any other airway surgery (Reardon *et al.,* 2008). Ordidge (2001) reported success of thermal palatoplasty at 66.5 % with 70 % of

owners subjectively considered the procedure to have improved their horse's performance. However, to date, no objective analysis of the procedure has been reported (Reardon *et. al.,* 2008).

2.1.3 Epiglottic Entrapment

Hawkins and Tulleners (1988) stated that epiglottic entrapment is a common problem in racehorses as compared to non-racing horses. This condition is when the aryepiglottic fold (subepiglottic membrane) becomes caught over the dorsal surface of the epiglottis (Figure IV), obscuring the normal appearance of the epiglottis (as cited by Parente, 2002). Davenport-Goodall and Parente (2003) also stated that epiglottic entrapment is a common cause of respiratory impedance and abnormal respiratory noises in racehorses (as cited by Perkins *et al.,* 2007). However, according to Beard and Waxman (2007), epiglottic entrapment is less likely to occur as compared to recurrent laryngeal neuropathy (RLN) or dorsal displacement of soft palate (DDSP).

Lumsden *et al.* stated that epiglottic entrapment is best to be resolved by axial division compared to resection (as cited by Parente, 2002). Axial division can either be performed by using a hooked bistoury or transendoscopically via the neodymium:yttrium aluminium garnet (Nd:YAG) laser (Parente, 2002). A study performed by Perkins *et al.* (2007) reported that among 16 standing horses that undergo transoral axial division using a hooked bistoury, 12 horses had complete resolution of epiglottic entrapment after 1 to 4 weeks following surgery. One horse also resumed racing after 2 weeks while owners, trainers reported that horses preoperatively affected with respiratory stridor no longer made abnormal respiratory noise during exercise.

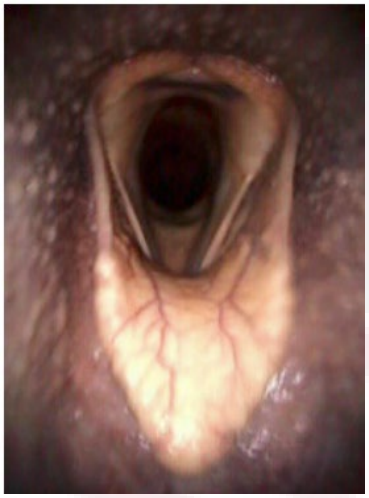

Figure I: Endoscopic still image from a normal larynx and soft palate at exercise

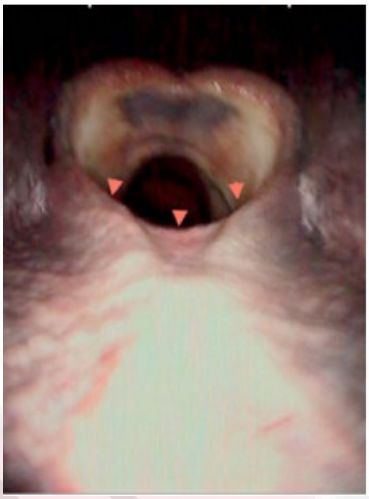

Figure III: Endoscopic image of the displacement of the palate over the top of the epiglottis

Figure II: Endoscopy image showing collapse of the left side of the larynx typical of recurrent laryngeal neuropathy

Figure IV: Endoscopy image showing an entrapped epiglottis

Retrieved from: www.rossdales.com

2.2 Lower Airway Disorders

The prevalence of lower airway diseases is quite high in equine athletes, with reports ranging from 20 % in adult horses to 80 % in young Thoroughbreds in training. Nevertheless, this prevalence may be underestimated due to the fact that most conditions progress subclinically, and relevant diagnostic procedures are sometimes difficult to implement routinely in the field (Erck-Westergren *et al.,* 2013). Couetil; Holcombe stated that the syndrome of tracheal inflammation (STI), inflammatory airway disease (IAD) and exercise-induced pulmonary haemorrhage (EIPH) are common conditions affecting the intermediate and lower respiratory tract of racehorses with each potentially leading to decreased performance (as cited by Courouce-Malblanc *et al.,* 2010). However, with regards to this study, only recurrent airway obstruction (RAO) and exercise-induced pulmonary haemorrhage (EIPH) will be discussed further.

In a study performed by Hotchkiss *et al.* (2007), whereby they utilised a questionnaire to estimate directly the prevalence of RAO in a horse population, findings indicate that over 20 % of the study population had exhibited coughing in the last 12 months, suggesting that respiratory disease is a significant health issue for horses in the general population. The high prevalence of RAO, as estimated by risk-screening questionnaire (RSQ), compared to the owner reported veterinary diagnosed prevalence is potentially as a result of owners' intervention, changing to minimal dust environment, without seeking veterinary advice.

For EIPH, it has been estimated that in Thoroughbreds, EIPH can be detected in almost 80 % of them during their racing career and blood is detected by endoscopic examination almost 43-75 % after a single race (Hinchcliff *et. al.*, 2005). Birks *et al.* stated that the prevalence of EIPH increases to >95 % with examination after a greater number of races (Sullivan *et. al,.*2015).

2.2.1 Recurrent Airway Obstruction (RAO)

Recurrent airway obstruction (RAO) or "heaves" is a chronic, reversible, inflammatory airway obstruction in mature horses (Leguillette, 2003). Although there are a number of possible aetiologies, RAO is most commonly triggered by the inhalation of microscopic organic dust and moulds naturally present in the horse's environment (Erck-Westergren *et al.,* 2013). These would then contribute to clinical signs according to Bracher *et al.,* such as cough, nasal discharge, increase in respiratory effort (as cited by Leguillette, 2003), accumulation of mucus in the tracheobronchial tree and decreased exercise tolerance (Erck-Westergren, 2013).

2.2.2 Exercise-induced Pulmonary Haemorrhage (EIPH)

Exercise-induced pulmonary haemorrhage is a unique respiratory condition in horses by which results in shedding of blood in the lungs and airways after strenuous exercise. In practice, diagnosis is basically made via observation of post effort epistaxis or blood within the trachea and lower airways (Erck-Westergren *et al.,* 2013). Performance wise, EIPH is reported to have provided with negative impacts on performance. As reported, horses with EIPH were less likely to win, finished an average of one length further behind winners when compared with horses without EIPH, and were less likely to earn above the 90th percentile in race earnings (Morley *et al.,* 2015). Severe (grade 4) EIPH also has a negative impact on long-term performance as compared to other grades of severity, however it is unclear to whether this is due to the biological effects of the condition or to management decisions based on knowledge of results of the endoscopic examination (Sullivan *et al.,* 2015).

Furosemide, a loop diuretic, has been used for more than 30 years to prevent or reduce the severity of EIPH in racehorses (Sullivan *et al.,* 2015). Kindig *et al.* stated that

administration of furosemide 4 hours prior to exercise reduces EIPH by up to 90 % in Thoroughbred racehorses running at 95 % of maximal oxygen intake (as cited by Erck-Westergren *et al.,* 2013). In another study performed by Sullivan *et al.* (2015) also reported that furosemide reduces the frequency and severity of EIPH in Thoroughbred racehorses. Sixty-eight percent of horses with endoscopically detectable EIPH experience a reduction EIPH severity after administration of furosemide.

3.0 MATERIALS AND METHODS

3.1 Study Design

This study was a prospective examination of the prevalence and, for the more frequently detected respiratory diseases, association with performance of surgically corrected Thoroughbred racehorses. The types of respiratory diseases that will be included for association with performance after surgery will only include respiratory diseases that can be surgically corrected and not for conservatively treated diseases. Criteria for enrolment in this study included completion of a flat race between 1000 and 1600 m run on turf at race tracks either in Perak Turf Club, Ipoh, Perak between 1st of January 2011 and 13th December 2015.

Results were obtained based on recorded veterinary examination findings following completion of race performed by veterinary surgeons from the Turf Club itself.

3.2 Endoscopic Examination

Rhinolaryngoscopic examination of one nostril, ipsilateral turbinates, nasopharynx and larynx was performed on unsedated horses following completion of race. Horses are restrained by a handler and a nose twitch was applied. A videoendoscope was inserted in

either one of the nostrils and the ventral meatus, turbinates, nasopharynx and larynx were examined. The image was displayed on a computer screen and scrutinised by at least 2 veterinary surgeons from the turf club. The examination included careful scrutiny of the pharynx and larynx. The position of the soft palate and epiglottis were also identified.

Respiratory diseases were identified accordingly as seem fit by the attending veterinary surgeon during that point of time. As practiced in Perak Turf Club, EIPH grade 1 and grade 2 were identified as bled and respiratory distress respectively. Dorsal displacement of the soft palate (DDSP) was considered clinically significant if it persisted after at least 2 swallowing attempt and was attempt both before and after tracheobronchoscopic examination of the horse. However, definitions of DDSP may vary accordingly. Epiglottic entrapment was diagnosed by the characteristic appearance of the entrapped epiglottic mucosa dorsal to the epiglottis. RLN was identified from the collapse of the left side of the larynx, which is typical in RLN.

3.3 Race Records

The year and date of races, horse name, MRA number, trainer's name, as well as comments on the respiratory findings obtained following completion of race were obtained from the records kept routinely after races from the turf club itself. Surgical corrections performed including the date of the surgery were also obtained and recorded respectively.

Additional information, racing history and signalment of the horse which include age (years), sex (gelding, mare or stallion), lifetime races or starts, duration of race (years), lifetime earnings (Malaysian Ringgit; MYR), lifetime wins, lifetime seconds and lifetime thirds were obtained from the database of Singapore Turf Club website, subset horse performance (http://www.turfclub.com.sg).

3.4 Statistical Analysis

Descriptive data were also collected for all horses. Only respiratory diseases that can be surgically treated were analysed for which are RLN, DDSP and epiglottic entrapment affected horses. However, only values for horses with a diagnosis of recurrent laryngeal neuropathy (RLN) that had undergone corrective surgery were compared with values for horses with the same diagnosis in which no surgeries were performed. The number of horses affected with DDSP and epiglottic entrapment that were surgically corrected was not significant for statistical analysis, therefore were not included. Other respiratory diseases that were not listed above which include EIPH Grade I and II, and RAO were treated conservatively instead of correctively via surgery thus were not fit for analysis. Statistical analysis was performed in SPSS for windows v20.

For the prevalence of respiratory diseases, year, age and problem were evaluated by Chi-Squared analysis with Yates correction where necessary. The *type 1* error was 5%. Proportions are reported as the observed value and 95 % confidence interval (CI). Unless stated otherwise, median and a range of 5-95 % were used as measures of central tendency and dispersion.

For association of surgical correction with racing performance, a Wilcoxon's signed rank test was used to determine whether the pre- and post-surgery performance index was significantly affected by surgery. Due to insignificant number of data for the different types of respiratory diseases except for RLN, no statistical analysis was done to associate surgical correction for DDSP and also epiglottic entrapment. However, lifetime earnings, lifetime races, pre- and post-surgery starts of horses that had undergone ventriculocordectomy were evaluated by paired Mann-Whitney U test.

4.0 RESULTS

A total of 3329 of horses were endoscoped following race at Perak Turf Club, Ipoh, as from 1st of January 2011 and 13th December 2015 and results recorded with respiratory diseases were a total of 239 horses respectively. For the purpose of this study, 199 horses were sorted out as a result of recurrence. Horses examined were 164 geldings (82.4 %), 23 mares (11.6 %) and 12 stallions (6.0 %) of median age 6 years (5-95 % range 3-9 years).

4.1 Prevalence of Respiratory Diseases

4.1.1 Respiratory Diseases in Relation to Year

Seven types of respiratory diseases were identified in conjunction to this study which are, respiratory distress and bled; EIPH grade 1 and 2 respectively, broken winded or RLN, DDSP, epiglottic entrapment, respiratory noises and others. From the year 2011 to 2015, problem that shows the highest case recorded was EIPH grade 1 or respiratory distress with 76 cases (38.2 %), followed by 60 cases of EIPH grade 2 (30.2 %), 35 cases of RLN (17.6 %), 8 cases for both epiglottic entrapment and others (4.0 %) and 6 cases each for both DDSP and respiratory noises (3.0 %) as shown as Figure V.

4.1.2 Respiratory Disease in Relation to Gender

Among the 199 horses examined, respiratory distress or EIPH grade 1 was detected in 65 geldings (32.7 %), 10 mares (5.0 %) and 1 stallion (0.5 %), in total 76 cases. This is followed by 60 cases for EIPH grade 2 or bled, 52 geldings (26.1 %), 5 mares (2.5 %) and 3 stallions (1.5 %) respectively. For broken winded or RLN, they were a total of 35 cases with 28 geldings (14.1 %), 3 mares (1.5 %) and 4 stallions (2.0 %). For both epiglottic entrapment

and others, with 8 cases each; there were 6 geldings (3.0 %) and 2 mares (1.0 %) for epiglottic entrapment and 6 gelding (3.0 %), 1 mare (0.5 %) and 1 stallion (0.5 %) for others. 6 cases each include DDSP and respiratory noises; DDSP detected in 3 geldings (1.5 %), 1 mare (0.5 %) and 2 stallions (1.0 %) while 4 geldings (2.0 %), 1 mare (0.5 %) and 1 stallion (0.5 %) each for respiratory noises (Figure VIII).

Chi-square test revealed that (x^2=17.893, *df*=12, *p*=.17) indicating that there is no significance or association between type of respiratory diseases in relation to the gender of the horse (Figure VII).

4.1.3 Respiratory Disease in Relation to Age

Descriptive analysis for age was calculated using MS Excel. A median age of 6 years was obtained from most of the diseases, which include EIPH grade 1 (5-95 % range 3-9 years) and grade 2 (5-95 % range 4-9 years), RLN (5-95 % range 3-9 years), epiglottic entrapment (5-95 % range 5-7 years) and others (5-95 % range 4-8 years). For respiratory noises, the median age was 5.5 years (5-95 % range 4-7 years) while for DDSP, the median age is 4.5 years (5-95 % range 4-8 years).

Chi-square test revealed that (x^2=44.806, *df*=36, *p*=.15) indicating that there is no significance or association between type of respiratory diseases in relation to the age in horses (Figure IX).

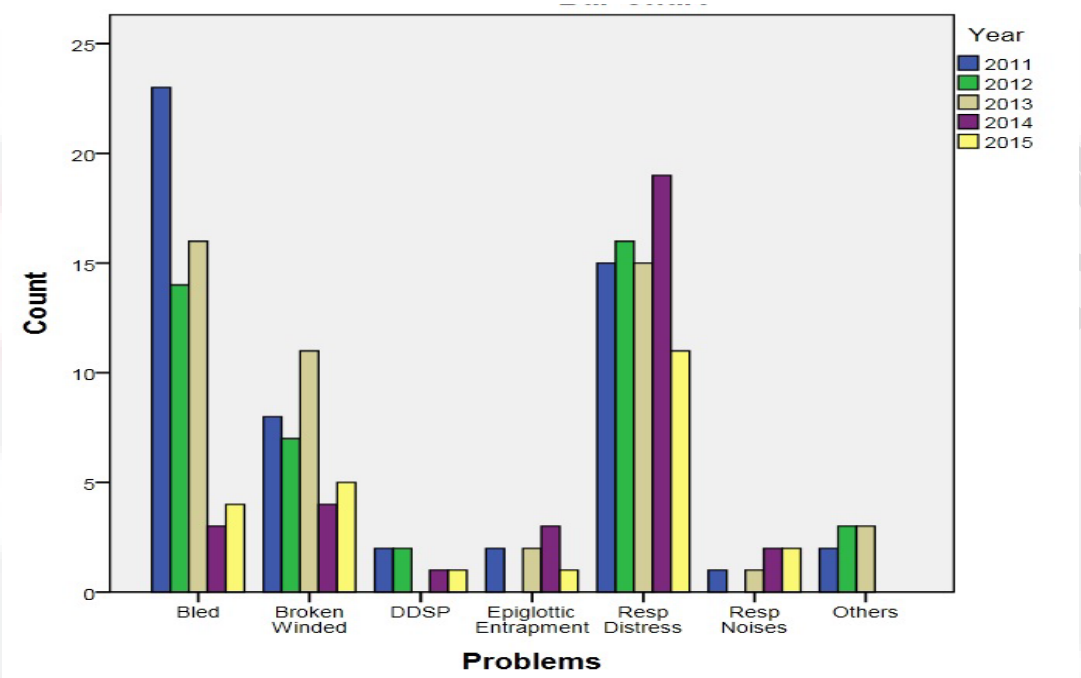

Figure V: A graph bar depicting the occurrence of respiratory problems with relation to year.

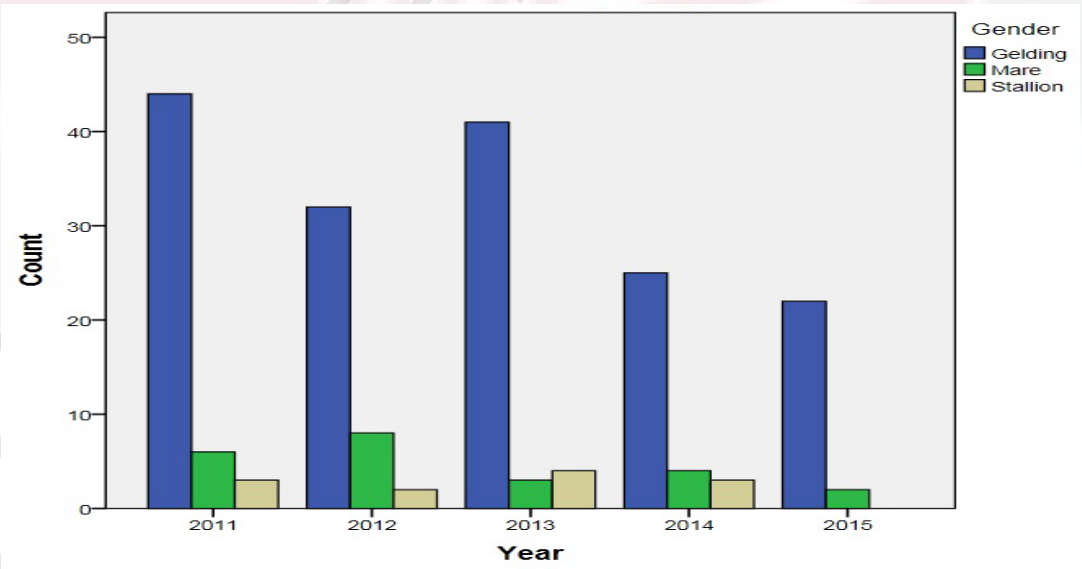

Figure VI: A graph bar depicting the number of affected horses in relation to gender yearly.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.983[a]	12	.116
Likelihood Ratio	14.949	12	.244
Linear-by-Linear Association	.004	1	.947
N of Valid Cases	199		

Figure VII: Chi-square results for respiratory problems in relation to gender.

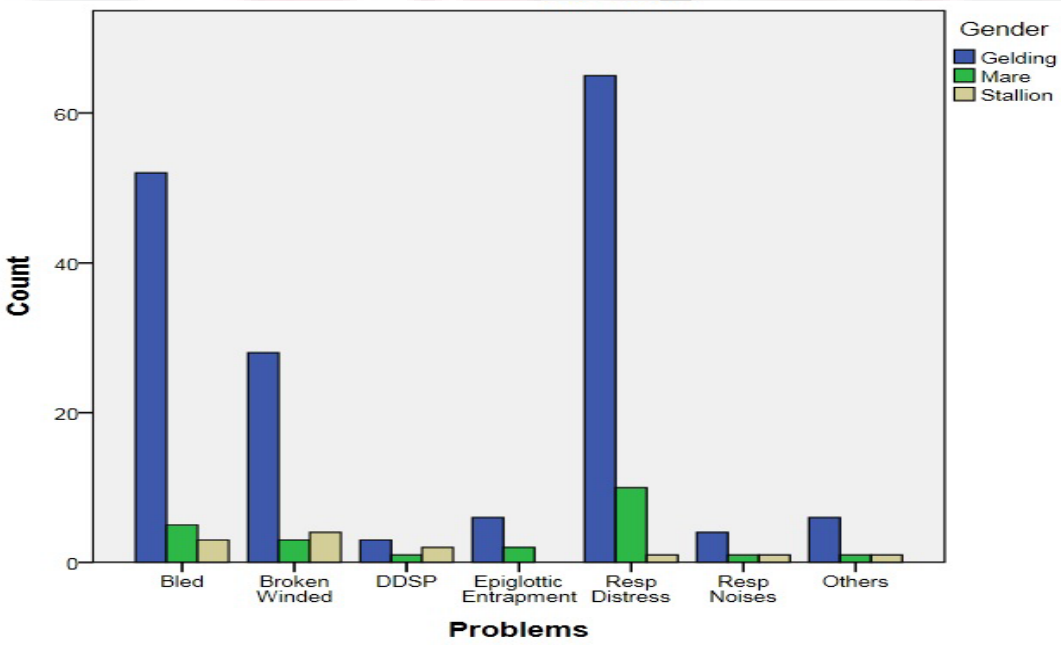

Figure VIII: A graph bar depicting respiratory problems in relation to gender.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	44.806[a]	36	.149
Likelihood Ratio	50.961	36	.050
Linear-by-Linear Association	.441	1	.507
N of Valid Cases	199		

Figure IX: Chi-square results for respiratory problems in relation to age.

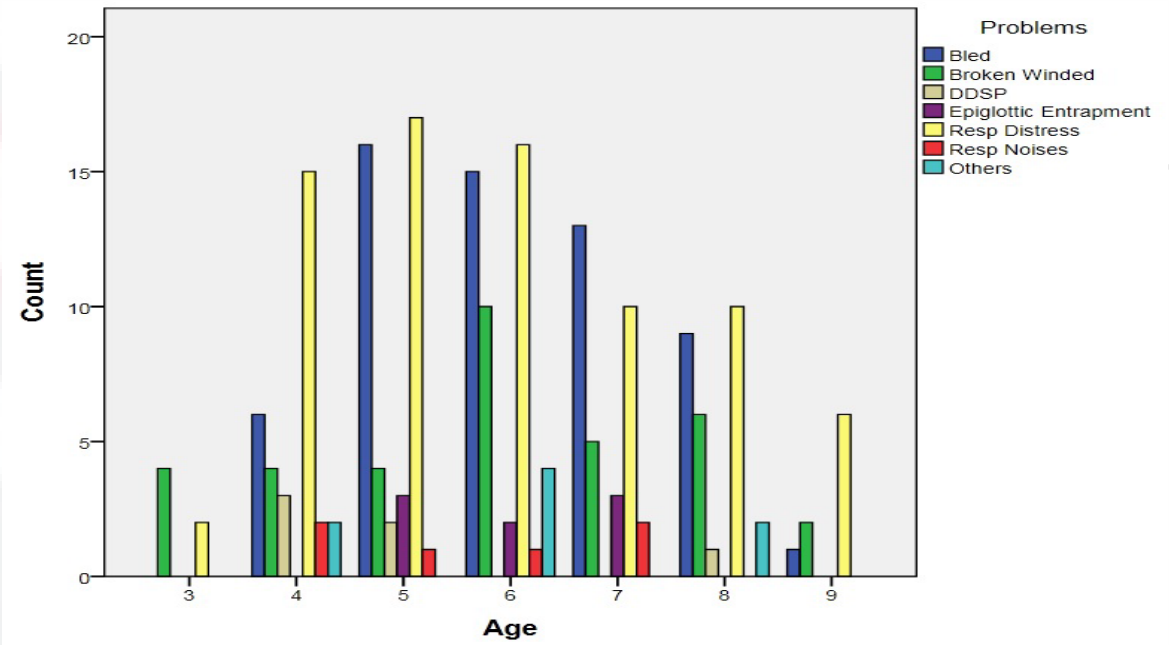

Figure X: A graph bar depicting respiratory problems in relation to age.

4.2 Respiratory Disease and Association with Performance

In total, out of 199 horses affected, only 23 (11.6 %) had undergone surgical correction leaving out another 176 horses (88.4 %). Only surgical correction for RLN, epiglottic entrapment and DDSP would be of importance in this study due to higher number of data compared to the other four diseases which were mostly conservatively treated.

From 35 horses that were affected with RLN, 18 horses (9.0 %) had surgery while 17 (8.5 %) other horses had not undergone surgery. For DDSP, out of 6 cases, only 1 (0.5 %) surgery was performed leaving another 5 more (2.5 %). For epiglottic entrapment, out of 8 cases (2.0 %), 4 had undergone surgery while 4 others (2.0 %) have not. Due to insignificant number of data for the different types of respiratory diseases except for RLN, no statistical analysis was done to associate surgical correction for DDSP and also epiglottic entrapment (Figure XI).

4.2.1 Lifetime Earnings

Mann-Whitney U test was done using lifetime earnings from both RLN affected horses surgically treated and not surgically treated as the variables. Null hypothesis (Ho) and alternative hypothesis (Hα) are as follows:

1. Ho: Affected horses with surgical correction ≠ better prognosis for successful races
2. Hα: Affected horses with surgical correction = better prognosis for successful races

The Mann-Whitney U test indicated that earnings for horses that had undergone ventriculocordectomy was greater compared to horses that had not undergone ventriculocordectomy, $U = 137.5$, $p = .609$, $r = 23.2$ (Figure XII). This shows that surgically treated horses does not necessarily resulted in higher earnings compared to not surgically treated.

4.2.2 Lifetime Wins

Lifetime wins from surgically corrected horses was compared with lifetime wins from horses not surgically corrected as the variables for the Mann-Whitney U test. Null hypothesis (Ho) and alternative hypothesis (Hα) are as follows:

1. Ho: Affected horses with surgical correction ≠ better prognosis for successful races
2. Hα: Affected horses with surgical correction = better prognosis for successful races

The Mann-Whitney U test indicated that wins for horses that had undergone ventriculocordectomy was greater compared to horses that had not undergone ventriculocordectomy, $U = 134.5$, $p = .535$, $r = .1$ (Figure XIII).

4.2.3 Lifetime Starts

Lifetime starts from surgically corrected horses was compared with lifetime wins from horses not surgically corrected as the variables for the Mann-Whitney U test. Null hypothesis (Ho) and alternative hypothesis (Hα) are as follows:

1. Ho: Affected horses with surgical correction ≠ better prognosis for successful races
2. Hα: Affected horses with surgical correction = better prognosis for successful races

The Mann-Whitney U test indicated that starts for horses that had undergone ventriculocordectomy was lower compared to horses that had not undergone ventriculocordectomy, $U = 141.5$, $p = .704$, $r = .06$ (Figure XIII).

4.2.4 Race Start Pre- and Post-operatively

Race starts records were obtained pre- and post-operatively and was tested using Wilcoxson's Signed Rank test. Test results revealed that 13 horses had a lower number of race starts following surgery compared to only 2 horses that had a higher number of race starts. 3 horses experienced no change following surgery (Figure XIV). The Wilcoxon's Signed-rank test indicated that pre-surgery race starts (Mdn = 18) were greater compared to post-surgery race starts (Mdn = 2.5), Z = 3.13, p > .001, r = .74.

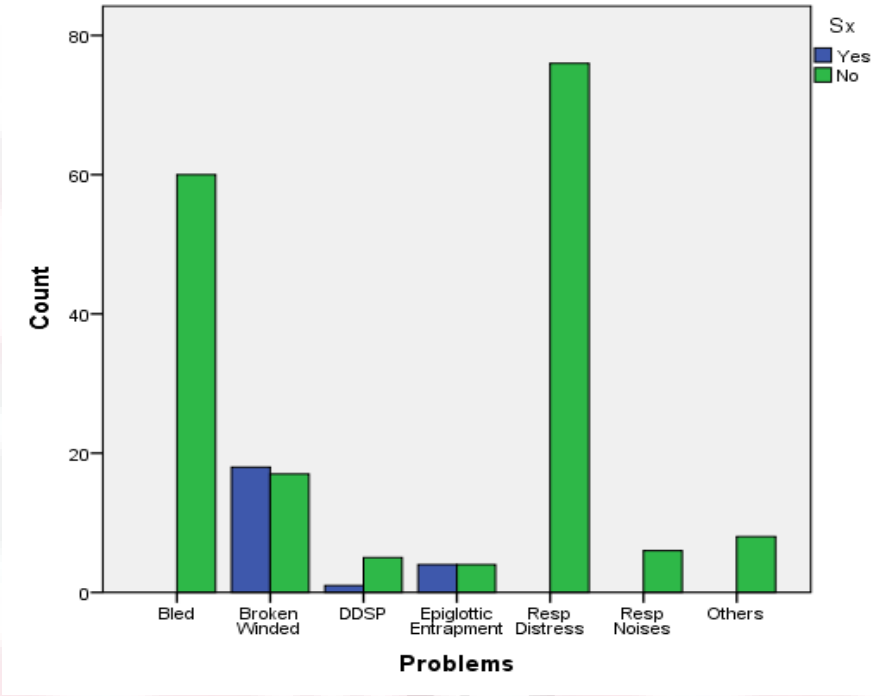

Figure XI: A graph bar depicting the number of horses that had undergone surgical correction in accordance to types of respiratory problems.

Ranks

	Surgery	N	Mean Rank	Sum of Ranks
Earnings	Yes	18	18.86	339.50
	No	17	17.09	290.50
	Total	35		

Test Statistics[a]

	Earnings
Mann-Whitney U	137.500
Wilcoxon W	290.500
Z	-.512
Asymp. Sig. (2-tailed)	.609
Exact Sig. [2*(1-tailed Sig.)]	.613[b]

Figure XII: Mann-Whitney U test of lifetime earnings for horses that had undergone ventriculocordectomy and horses without ventriculocordectomy.

Ranks

	Surgery	N	Mean Rank	Sum of Ranks
Races	Yes	18	17.36	312.50
	No	17	18.68	317.50
	Total	35		
Wins	Yes	18	19.03	342.50
	No	17	16.91	287.50
	Total	35		

Test Statistics[a]

	Races	Wins
Mann-Whitney U	141.500	134.500
Wilcoxon W	312.500	287.500
Z	-.380	-.621
Asymp. Sig. (2-tailed)	.704	.535
Exact Sig. [2*(1-tailed Sig.)]	.708[b]	.546[b]

Figure XIII: Mann-Whitney U test of lifetime races and wins for horses that had undergone ventriculocordectomy and horses without ventriculocordectomy.

Ranks

		N	Mean Rank	Sum of Ranks
Post_sx - Pre_sx	Negative Ranks	13[a]	8.85	115.00
	Positive Ranks	2[b]	2.50	5.00
	Ties	3[c]		
	Total	18		

Test Statistics[a]

	Post_sx - Pre_sx
Z	-3.125[b]
Asymp. Sig. (2-tailed)	.002

Figure XIV: Wilcoxon Signed Rank test of pre- and post-surgery starts for horses that had undergone ventriculocordectomy.

5.0 DISCUSSION

Present study reveals that the prevalence of respiratory diseases in Thoroughbred racehorses competing in races is low. In comparison to a study previously performed by Davidson & Martin (2003) where 40 % of the case had RLN, 30 % had pharyngeal collapse and 11 % with DDSP among 77 sport horses, in the present study, RLN was at 18 % and pharyngeal collapse was categorized under 'others' at 4.0 % while DDSP at 3.0 %. However, the prevalence from this study by Brown *et al.* (2005), among 744 horses, 0.9 % was affected by epiglottic entrapment, 0.3 % with laryngeal hemiplegia and 0.5 % with DDSP. In the present study, 4.0 % was affected by epiglottic entrapment. Regardless of both the study mentioned, results revealed that none of them matches or runs close to any of the prevalence stated. That is why as stated earlier on, the prevalence of upper airway disorders is difficult to ascertain as such the condition is not evident upon resting examination (Erck-Westergren *et al.,* 2013).

For lower airway disease, in a study performed by Hotchkiss *et al.* (2007), RAO was identified affecting 20 % of the population in the last 12 months. Based on the present study, RAO was at 3.0 %, which is considered as quite low as compared to the study being performed. For EIPH, it has been estimated that in Thoroughbreds, EIPH can be detected in almost 80 % of them during their racing career and blood is detected by endoscopic examination almost 43-75 % after a single race (Hinchcliff *et al.*, 2005). From the present study, 38.2 % of the study population were affected by EIPH grade 1, which is respiratory distress and 30.2 % were affected by EIPH grade 2 or bled. However, since the gradings of EIPH from the present study differs from the grading of EIPH from previous study, no comparison of prevalence based on gradings of EIPH can be made.

Chi-square analysis revealed that there was no association between age and gender with the occurrence of respiratory diseases. This is since the factor that predisposes a horse

to respiratory disease is multifactorial, unlike age and gender wise. First would be the fact that horses are obligate nasal breathers, which predisposes to the collapse of airways as transmural pressure increases (Art & Lekeux, 2005). Compared to age and gender, the discipline performed by different horses with relation to the nature and the severity of the disease may be the predisposing factor (Erck-Westergren *et al.,* 2013). Allen & Franklin (2010) also mentioned that type of exercise performed will have an impact on the respiratory performance as fatigue of the respiratory musculature may occur, but depends on the equestrian discipline performed.

For the association of increase in performance in relation to surgically corrected horses, statistical analysis revealed that following surgery, none of variables are associated with increase in performance. Variables include lifetime earnings, lifetime wins and lifetime starts between those that have undergone surgery and have not undergone surgery. For the Wilcoxson's Signed Rank test, test results also revealed negative results in term of race starts pre-operatively. Horses that have gone surgery are more likely to have reduction in race starts as compared to before the surgery is being done.

As practiced by Perak Turf Club, ventriculocordectomy has been seen to be the choice of treatment in RLN or laryngeal paralysis. In a study by Tetens *et al.* (1996), whereby 92 horses with laryngeal paralysis were solely treated with ventriculocordectomy, it revealed that horse performance improved up to 59 % following surgery (cited by Leguillette, 2003). A clinical report on unilateral laser assisted ventriculocordectomy in 22 horses in a study by Henderson *et al.,* 2007 revealed that exercise intolerance improved post operatively in 8 of 10 horses that are presented with clinical signs (Cramp & Barakzai, 201).

Present study however revealed differently whereby there were no significant association between all three variables; lifetime earnings, lifetime wins and lifetime starts with that of surgically treated or non-surgically treated horses.

5.0 CONCLUSION AND RECOMMENDATIONS

As the conclusion, the prevalence of respiratory diseases in racehorses following race is high especially for EIPH. However, although EIPH is considered a normal condition in racehorses following strenuous exercise, preventive measures should be taken as EIPH can also cause death. For the study of surgical correction and impaired race performance, none of the variables are significant to that of improvement in race performance. However, this does not significantly prove that surgery will not do justice in terms of race performance.

Recommendations include widening the sample size for the purpose of this study. A larger size of sample population will definitely provide accurate results due to increase in specificity and sensitivity. In terms of recorded data, it would help to provide with complete data records for example EIPH grade from 0 to 4, which conveniently helps in comparing with other studies as a reference. For example, a study performed by Hinchcliff *et al.* (2005) to detect EIPH impairment with racehorses uses additional indicators of performance such as race placement, money earned and distance finished behind winner along with adjustments for confounding factors, and a large number of study samples. Due to the fact that the present study does not have sufficient grading of EIPH and was found to be different to grading from previous studies, a comparison of prevalence based on EIPH grading cannot be performed.

In terms of surgically treated horses, since this study focuses on surgically corrected horses following race, this limits the size of the study population. Fewer horses reduce the ability to detect significant association between the variables and performance.

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APPENDIX

Table i: A table of the type of respiratory diseases in accordance to year.

Problems	Year					Total
	2011	2012	2013	2014	2015	
Bled (EIPH Grade I)	23	14	16	3	4	60
% of Total	11.6%	7.0%	8.0%	1.5%	2.0%	30.2%
Broken Winded (RLN)	8	7	11	4	5	35
% of Total	4.0%	3.5%	5.5%	2.0%	2.5%	17.6%
DDSP	2	2	0	1	1	6
% of Total	1.0%	1.0%	0.0%	0.5%	0.5%	3.0%
Epiglottic Entrapment	2	0	2	3	1	8
% of Total	1.0%	0.0%	1.0%	1.5%	0.5%	4.0%
Respiratory Distress (EIPH Grade II)	15	16	15	19	11	76
% of Total	7.5%	8.0%	7.5%	9.5%	5.5%	38.2%
Respiratory Noises	1	0	1	2	2	6
% of Total	0.5%	0.0%	0.5%	1.0%	1.0%	3.0%
Others	2	3	3	0	0	8
% of Total	1.0%	1.5%	1.5%	0.0%	0.0%	4.0%
Total	53	42	83	32	24	199
% of Total	26.6%	21.1%	24.1%	16.1%	12.1%	100.0%

Table ii: A table of horses affected with respiratory diseases in accordance to year and gender.

Year	Gender			Total
	Gelding	Mare	Stallion	
2011	44	6	3	53
% of Total	22.1%	3.0%	1.5%	26.6%
2012	32	8	2	42
% of Total	16.1%	4.0%	1.0%	21.1%
2013	41	3	4	48
% of Total	20.6%	1.5%	2.0%	24.1%
2014	25	4	3	32
% of Total	12.6%	2.0%	1.5%	16.1%
2015	22	2	0	24
% of Total	11.1%	1.0%	0.0%	12.1%
Total	164	23	12	199
% of Total	82.4%	11.6%	6.0%	100.0%

Table iii: A table of horses affected with respiratory diseases in accordance to gender.

Problems	Gender			Total
	Gelding	Mare	Stallion	
Bled (EIPH Grade I)	52	5	3	60
% of Total	26.1%	2.5%	1.5%	30.2%
Broken Winded (RLN)	28	3	4	35
% of Total	14.1%	1.5%	2.0%	17.6%
DDSP	3	1	2	6
% of Total	1.5%	0.5%	1.0%	3.0%
Epiglottic Entrapment	6	2	0	8
% of Total	3.0%	1.0%	0.0%	4.0%
Respiratory Distress (EIPH Grade II)	65	10	1	76
% of Total	32.7%	5.0%	0.5%	38.2%
Respiratory Noises	4	1	1	6
% of Total	2.0%	0.5%	0.5%	3.0%
Others	6	1	1	8
% of Total	3.0%	0.5%	0.5%	4.0%
Total	164	23	12	199
% of Total	82.5%	11.6%	6.0%	100.0%

Table iv: A table of horses affected with respiratory diseases in accordance to age.

Problems	Year							Total
	3	**4**	**5**	**6**	**7**	**8**	**9**	
Bled (EIPH Grade I)	0	6	16	15	13	9	1	60
% of Total	0.0%	3.0%	8.0%	7.5%	6.5%	4.5%	0.5%	30.2%
Broken Winded (RLN)	4	4	4	10	5	6	2	35
% of Total	2.0%	2.0%	2.0%	5.0%	2.5%	3.0%	1.0%	17.6%
DDSP	0	3	2	0	0	1	0	6
% of Total	0.0%	1.5%	1.0%	0.0%	0.0%	0.5%	0.0%	3.0%
Epiglottic Entrapment	0	0	3	2	3	0	0	8
% of Total	0.0%	0.0%	1.5%	1.0%	1.5%	0.0%	0.0%	4.0%
Respiratory Distress (EIPH Grade II)	2	15	17	16	10	10	6	76
% of Total	1.0%	7.5%	8.5%	8.0%	5.0%	5.0%	3.0%	3.0%
Respiratory Noises	0	2	1	1	2	0	0	6
% of Total	0.0%	1.0%	0.5%	0.5%	1.0%	0.0%	0.0%	3.0%
Others	0	2	0	4	0	2	0	8
% of Total	0.0%	1.0%	0.0%	2.0%	0.0%	1.0%	0.0%	4.0%
Total	6	32	43	48	33	28	9	199
% of Total	3.0%	16.1%	21.6%	24.1%	16.6%	14.1%	4.5%	100.0%

Table v: A table of horses affected with respiratory diseases that were surgically treated.

Problems	Surgically Treated		Total
	Yes	No	
Bled (EIPH Grade I)	0	60	60
% of Total	0.0%	30.2%	30.2%
Broken Winded (RLN)	18	17	35
% of Total	9.0%	8.5%	17.6%
DDSP	1	5	6
% of Total	0.5%	2.5%	3.0%
Epiglottic Entrapment	4	4	8
% of Total	2.0%	2.0%	4.0%
Respiratory Distress (EIPH Grade II)	0	76	76
% of Total	0.0%	38.2%	38.2%
Respiratory Noises	0	6	6
% of Total	0.0%	3.0%	3.0%
Others	0	8	8
% of Total	0.0%	4.0%	4.0%
Total	23	176	199
% of Total	11.6%	88.4%	100.0%