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**What is the impact of hormone fluctuation on the perimenopausal voice,
and are current management strategies fit for purpose?**

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Part One: The Portfolio

Introduction/Rationale

Perimenopause is the period that surrounds the final years of a woman's reproductive life, associated with profound reproductive and hormonal change (McCarthy, M., Raval, 2020). It is characterised by a gradual decline in ovarian function, leading to hormonal fluctuations, particularly in oestrogen and progesterone levels (Lennell et al., 2020). These hormonal changes are associated with a range of physiological and psychological symptoms, which may impact the female singing voice (Lennell et al., 2020). This, combined with the effects of the natural ageing process, can prove to be a difficult transitional period for some female singers.

As a singer in a large, annually auditioned symphonic chorus comprising a significant number of women over the age of fifty, I have become acutely aware of the stresses that the changing voice places upon these singers and the need for education and support around the subject matter to enable these highly skilled women to continue to perform at the required standard.

Vocal complications during this phase may lead to missed rehearsals and failed auditions due to decreased range, vocal instability and problems with pitching.

Due to the lack of public information regarding possible vocal change in perimenopause, singers are often unaware of potential vocal complications during this time, with women often attributing changes in vocal health, agility and performance to poor technique and the ageing process (Katarzyna et al., 2019). As a result, many may not receive the most appropriate care.

With advanced healthcare and an increased ageing population, many women will sing for a long number of years after menopause. It is, therefore, vital that they are able to make this transition successfully.

In this study, I intend to explore the symptoms of perimenopause and the impact of these symptoms on the voice. From these findings, I will look at ways both the individual and organisations can effectively manage this transitional period, thus allowing the singer to continue performing at the required level.

Planned Programme of Study

Planned Study						
Consider topic and learning objectives	1/8/2023					
Source and read relevant literature	1/8/2023 onwards					
Write Literature Review		10/09/2023				
Write Critical Reflection			10/10/2023			
Sumit Draft Assignment				20/11/2023		
Final Ammendments					27/11/2023	
Submit Final Assignment						7/12/2023

Objectives of the Study

The study aims to examine the impact of hormones on the perimenopausal voice, exploring the effect of declining oestrogen and progesterone and other mitigating factors on vocal health. From this data, I will consider current management strategies and their efficacy in assisting women through this transitional period.

The structure of the Literature Review will be as follows.

Hormonal Changes During Perimenopause

To define the hormones involved in perimenopause and explore the role that they have on vocal health.

- Definition and duration of perimenopause
- Overview of hormonal changes during perimenopause
- Definition of oestrogen and the impact of oestrogen decline on the voice
- Definition of progesterone and the impact of progesterone decline on the voice
- The role of hormone receptors
- Evidence of the impact of declining oestrogen and progesterone as demonstrated in the menstrual cycle
- The role of testosterone and its impact on the voice

Effects of Hormonal Changes on Vocal Quality

To examine the impact of reproductive hormones on voice quality.

- Research on changes in vocal timbre and resonance during perimenopause
- Studies on perimenopause-related vocal hoarseness and voice fatigue
- Impact of hormonal fluctuations on vocal stability and smoothness
- Effects of Hormonal changes on vocal range and control
- Research on decreased vocal range and flexibility during perimenopause
- Studies on reduced vocal control and precision in pitch and dynamics
- Impact of hormonal fluctuations on vocal endurance and breath control

Physiological Mechanisms Underlying Hormonal Impacts on the Voice

- To gain an understanding of the physiology and mechanics of the voice and vocal apparatus.
- Review of vocal anatomy and physiology
- To consider the impact of the ageing process on the voice
- Interaction between hormones and vocal fold hydration
- Influence of hormonal changes on vocal fold thickness and elasticity

Measurement and Management Strategies

To gain an understanding of current methods and management strategies

- Methods of voice assessment
- Hormone Replacement Therapy and its effects on the voice
- Lifestyle modifications
- Vocal Support, including vocal warm-up exercises and techniques for maintaining vocal health
- Psychological and emotional support for singers going through perimenopause

Methods and Resources

This desk-based Literature Review focuses on the symptoms of perimenopause and aims to determine a possible link between hormonal change and vocal quality. By evidencing the connection between hormones and the voice, I will explore the various ways in which these voice changes manifest and examine if current management strategies are effective in addressing these changes.

By addressing the effectiveness of these management strategies, I aim to identify any areas of concern relating to vocal management that could be improved to help women sing successfully through perimenopause and beyond.

Due to the nature of the subject matter, I will draw upon literature from medical and vocal pedagogy employing a mixed-method approach that combines both quantitative and qualitative data. According to Creswell et al. (2018), this approach offers a way to triangulate data, cross-validate findings, and strengthen the overall study by taking advantage of the strengths of both forms of research.

Given the broad nature of the research title, it will follow a thematic approach (Braun et al., 2006). This will allow me to identify and analyse recurring themes associated with hormonal fluctuations during perimenopause, “finding repeated patterns of meaning” (Braun et al., 2006). These themes will include hormonal change during perimenopause, the effects of hormonal change on voice quality, physiological mechanisms underlying hormonal impacts on the voice, and vocal measurement and management strategies.

By gaining a deeper understanding of these themes and identifying further patterns and key trends in vocal change during this period, I will be able to review the efficacy of management strategies and identify any possible gaps in these current management methods.

Meta-analysis will be used to synthesise the data, as, according to Cooper (2017), it allows for a more objective synthesis of research findings and can provide a more precise estimate of the effect of a particular intervention than any individual study alone.

The research will be conducted ethically and transparently, paying particular attention to data quality and validity and acknowledging appropriate sources (Bryman, 2016).

Preliminary research was conducted through keyword searches on academic databases, such as Google Scholar and PubMed, to identify relevant publications from various disciplines. Initial search phrases included:- What is perimenopause? What is the impact of perimenopause on the voice? These were later refined to include the effects of hormones on the perimenopausal voice and the impact of ageing on the female voice. Later, perimenopausal management strategies and how to measure voice complaints in perimenopause were explored.

Generic articles on perimenopause were returned; however, few detailed explanations of symptoms associated with this transitional phase, and none cited vocal complications.

From here, I returned to mainstream data sources and the NHS to provide a list of symptoms associated with perimenopause. This offered a comprehensive list of mental and physical symptoms such as low mood, anxiety, low self-esteem and cognitive issues affecting memory and concentration, vasomotor symptoms such as hot flushes and palpitations, headaches, sleep disturbances, urogenital symptoms, muscle and joint pain, weight gain and changed body shape, skin changes and reduced sex drive, however, with no mention of possible voice complications (NHS, 2023).

From identifying the symptoms associated with this transitional phase, I was able to return to primary sources to corroborate my findings (Brinton et al., 2015; Schmidt and Rubinow, 2009; Delamater and Santoro, 2018). My aim was to understand why these symptoms appear in perimenopause and what causes them. Many articles indicated the fluctuation of sex hormones - oestrogen, progesterone and testosterone to be the key players in the onset of symptoms in perimenopause (Santoro, 2016; Hale et al., 2014), with a pivotal article by Abitbol et al. (2019) recognising the impact of these hormones on the larynx. Having made this connection with the voice, I returned to Google Scholar, refining the search to perimenopause and the voice. Again, little research appeared in the search engine, with only five articles published since 2019.

By employing a purposeful sampling approach to identify information-rich cases (Cresswell et al., 2011), I identified Bozeman et al. (2022) and Abitbol (2019) as key contributors.

Bozeman et al. (2022) confirmed the impact of hormonal change on the female voice and the role of reproductive hormones on receptors throughout the body, including the neuromuscular,

respiratory, and skeletal systems, connective tissues, gut and larynx. Furthermore, they highlighted the impact of hormone levels on the central nervous system, which supports the systems of phonation, emotion, and communication.

Abitbol (2019) validated the presence of oestrogen in the larynx, identifying it as a secondary sex organ that is influenced by hormonal fluctuations leading to vocal instability around perimenopause and menopause.

These were pivotal articles as they offered vital information relevant to the study, corroborating the impact of hormones on the larynx and voice instability in perimenopause.

I returned to Google Scholar to identify further peer-reviewed articles on the impact of progesterone and testosterone on the perimenopausal voice. There were fewer studies correlating to the voice. Further reading indicated this was due to the complexities of studying the biological mechanisms of these hormones (Santoro, 2016); however, literature did confirm the positive influence of progesterone and testosterone on the vocal apparatus (Behrman et al. 2015; Scott, 2020). Related articles on the menstrual cycle also corroborated the influence of these hormones on the voice.

Once I had been able to confirm the link between hormones and the voice, I was able to use content analysis to reveal various trends in voice complications associated with hormone fluctuations, such as a change to vocal resonance, hoarseness and fatigue, and decreased vocal range. (Krippendorff, 2013). I was aware, however, that due to the nature of the study, data was limited, and therefore, endeavoured to use reliable, valid, and relevant data.

I was then able to “footnote chase”, browsing references of selected reports and citation indices, specifically those cited by both Abitbol and Bozeman, to open up a wider body of research relevant to the study. This increased the body of research significantly.

As Bozeman’s data was particularly relevant to the study, I purchased the book “Singing through Change: Women Voices in Midlife, Menopause and Beyond”. This was insightful, as it was written from both a clinical and vocal pedagogy perspective, summarising current research on adult female voice change whilst providing individual case studies and anecdotes from women who have sung through the transitional phase. It also offered individualised solutions to many of the problems faced by women during this time.

It also highlighted the need to consider each case individually; however, it also noted that cross-training for the voice was perhaps the most effective way of managing vocal issues during this time (Bozeman, 2021). This involves training the voice through exercises from different disciplines, such as singing, speaking, and acting, and extending the voice throughout the entire range, addressing various aspects of vocal production, such as breathing, resonance, and articulation, to improve the overall health and function of the voice.

I then drew upon my knowledge and other vocal pedagogues to consider suitable vocal exercises to address these issues (Appendix).

From an epistemological perspective, the inclusion of grey/peer-reviewed clinical literature enabled me to align with the positivist movement, assuming that there is a reality that can be objectively observed and measured, with scientific research providing an accurate representation of reality (Bryman, 2016). Furthermore, the inclusion of this data enabled me to increase the validity of the research, discarding unsuitable articles that may be biased or unreliable. This was particularly important given the size and scope of the research project.

Due to time constraints, I was unable to carry out an exhaustive review of all the literature available on vocal complications during perimenopause; however, I condensed the data by citation analysis to include the most influential articles (McCain, 1990) and refined the data search to display articles from 2000 onwards to keep the research current (D'haeseleer (2012), Hamdan (2017), Moseley (2020)). However, in doing so, I was keen to ensure that pivotal historical articles on the subject matter were not missed, as these can provide valuable insight into the evolution of the subject matter.

By using a hermeneutics approach to interpret the data (Riessman, 2008), I was able to evidence the various changes in voice quality. I also spoke to many choral singers and close associates to gain an understanding of the impact of perimenopause on their voices and what, if any, intervention they had received. This allowed me to gain a complete understanding of the subject matter before exploring the efficacy and suitability of the intervention (Farrncourt, 2017).

Before exploring current management strategies and ways of assessing vocal change, I considered the impact of ageing on the voice. This was important as it can affect many areas of the vocal apparatus, including vocal fold elasticity and mobility. Many articles were available on voice change during this time, which allowed me to gain a deeper understanding of possible issues that may arise. This was useful when considering vocal exercises and management strategies.

In drawing conclusions on the appropriateness of current intervention and management strategies, I was aware that my perspective might introduce an element of bias.

Having personally seen the effects of perimenopause on the voices of several close friends and choral members and the lack of diagnosis and cohesive support that was offered to them during this time, I was aware that this might influence the conclusions I drew on the suitability of intervention. I, therefore, tried to address analytical bias by acknowledging and challenging personal assumptions, carefully considering the argument that whilst hormonal fluctuations may affect the voice during perimenopause, the impact of these changes may not be significant

enough to warrant significant coverage in mainstream literature. This was to ensure objective and unbiased conclusions.

Sampling bias was also considered when selecting suitable case studies, including multiple sources of evidence (Guba & Lincoln, 2005), to ensure the credibility and impact of the research findings (Creswell, 2014.) I also used a hermeneutics approach to interpret the data to ensure conclusions were based on objective analysis.

Critical Reflection - The Learning Process

According to Dewey (1933), we learn not only from the acquisition of knowledge but through reflection on experience. Critical reflection is, therefore, considered a vital component of the research project that enables the researcher to reflect on the methodology, biases and limitations of the study to ensure valid and reliable conclusions. Influential reflective practitioners Dewey (1933) and Kolb (1984) also acknowledge that it enables the researcher to generate new ideas, theories, or perspectives that can lead to further research questions and directions. Schön (1983) further emphasises the importance of reflection in learning and professional development, arguing that reflection-in-action and reflection-on-action are essential to effective problem-solving and decision-making in complex situations.

Reflective frameworks commonly used to facilitate change in vocal pedagogy include Gibbs Reflective Cycle (1988), Kolbs Experiential Learning Cycle (1984), Bortons Development Framework (1970) and Mezirows Transformation (1975). These were considered alongside PICO (Population, Intervention, Comparison, Outcome) and CASP (Critical Appraisal Skills Programme, 1993), often used in healthcare settings.

As the research question aligned with medical and vocal pedagogy, Gibbs Reflective Cycle (1988) seemed an applicable model to reflect upon my learning experience.

The Gibbs Reflective Cycle (1988) is a framework for reflection often used in education and healthcare that helps individuals explore and evaluate their experiences in a structured and systematic way with a view to improving practice by identifying areas for improvement or change. Bulman et al. (2013) highlight the appropriateness of the reflective model in nursing education, with Moon (2004) stating that the model has been used extensively in various educational contexts to facilitate reflective learning.

It comprises six stages: Description, Feelings, Evaluation, Analysis, Conclusion and Action Plan.

Gibbs Reflective Cycle



Initial analysis of the literature allowed me to identify that the most probable cause of vocal complications during Perimenopause was the fluctuation of oestrogen and progesterone. This was confirmed in pivotal studies by Abibtol (1999) and Bozeman (2023).

In comparison to previous studies where the amount of literature available was overwhelming, the subject matter of this study meant there were fewer articles to review, making it easier to pinpoint these significant studies.

However, literature concerned with the perimenopausal voice was scarce, and there was no mention on general websites of the possible impact of this transitional phase on the voice. While the relatively small number of studies made it more challenging to collate relevant information, it revealed the literature review's first theme concerning the lack of education and awareness of voice complications linked to perimenopause and menopause.

I had already identified this as an area of concern through personal experience, with many older women in choral settings struggling with loss of range and other quality issues. They had little knowledge of the possible impact of hormones on the voice during this time, and educational tools were sparse. Many struggled to find suitable interventions, and some long-standing members of these reputable symphonic choruses failed re-auditions due to vocal instability possibly linked to perimenopause.

The emergence of this initial theme was a turning point in the study as it encouraged me to seek further themes to shape my research, allowing me to organise information in a more methodical manner.

From here, I drew upon medical and vocal pedagogy to define oestrogen and progesterone and identify the impact of the fluctuation of these hormones on the voice. Perhaps the most challenging aspect of this was interpreting aspects of medical data and terminology.

Whilst it became clear that oestrogen significantly impacted the maintenance and health of the vocal folds (Titze, 1994), the effects of progesterone were more complex to define.

Many of the fluctuating effects of progesterone were similar to those of oestrogen, and most studies considered the effects of these hormones as a whole. I found this information difficult to assimilate and record without repetition in the narrative.

After spending a considerable amount of time trying to digest the literature and understand the complex medical terminology in many of the case studies, I concluded that the intricate relationship between oestrogen, progesterone and testosterone on the voice was an under-researched area, enabling the second theme to emerge. This pertained to the intricate relationship of oestrogen, progesterone and testosterone and the impact of fluctuations on the perimenopausal voice.

I struggled to find relevant articles on the relationship between these hormones and the voice during perimenopause. I had to extend the research to that of the menstrual cycle for corroboration (Behrman, 2020; Sataloff, 2021).

From here, I turned to research on specific voice complications and changes in vocal quality during this phase. I found this research easier to synthesise as I could draw upon my experience as a singer and musician to understand the literature from both an academic and personal perspective.

It felt prudent at this stage to consider the ageing process on the voice. Again, this literature was firmly rooted in the medical field, covering anatomy and physiology. Whilst it was necessary to incorporate this information into the study, I found it difficult to compress the data to a manageable size without becoming too descriptive and detracting from the main research question.

This allowed me to conclude the study with an appraisal of current measurement tools to assess vocal change and an overview of management strategies. I then looked back at the vocal symptoms of perimenopause to assess if the management strategies were addressing these

problems, thus identifying gaps in care and strategies that require change to meet the needs of perimenopausal women.

The final analysis revealed a gap in education and awareness in mainstream literature pertaining to vocal complications during perimenopause. It also highlighted that each individual's response to perimenopause is extremely varied, both in symptoms and duration, which should be taken into consideration when planning future management strategies.

This requires further research to deliver effective and accurate information to this demographic.

Reflecting on the process as a whole, I noted the following:-

I enjoyed the process of collating and reviewing data from both vocal pedagogy and medical sources and gaining a greater in-depth understanding of the role of oestrogen and progesterone on the voice. However, I did find it difficult to fully comprehend the underlying mechanisms that caused the fluctuations between these hormones during perimenopause.

As I refined this area of the research, I found the literature more challenging to read as many of the reports were medically based using scientific lexicon. This was a frustrating process and very time-consuming in some instances.

I was pleased, however, to evidence the impact of hormonal fluctuations on the voice during Perimenopause and demonstrate the need for further education around the subject matter.

I also felt immense pressure due to time constraints and external commitments.

This impacted the number of hours I could feasibly commit to the research; reading became very disjointed, and progression was slow.

This was compounded by switching research topics from perfectionism to the current title and five weeks of summer travel.

I also found the portfolio challenging to write. Although the structure of the master's Course introduced key concepts of methodology as an independent study prior to the desk-based learning project, I had several prolonged interruptions to study due to ill health. During this time, I had forgotten many of the methodologies involved in research and had to revisit many of the previous teachings on the subject matter. This again involved additional time, which should have been spent synthesising data on the current research question.

In conclusion, time management was the most challenging part of the research project.

It was only as I was nearing the submission deadline that I was able to allocate dedicated hours to the project. I marked the time off in the diary and worked from the library to ensure no distractions. In retrospect, I should have done this earlier. By increasing the time spent

researching the literature and adhering to set timeframes to discuss progress with my tutor, I would have undoubtedly produced a more thorough and comprehensive study.

Gibbs Reflective Cycle has highlighted the need to structure and schedule study periods in the diary to enable me to meet proposed study deadlines in the future.

Personal Action Plan for Future Study

1. Structure future research by diarising specific study time.
2. Keep in regular contact with my tutor to ensure progress.
3. Undertake further research on methodologies and models of reflective practice to expand my knowledge base.

Research Action Plan

1. Consider research on the best way to educate women on possible voice complications during perimenopause.
2. Create a manifest to educate female singers and choir directors on the implications of perimenopause.
3. Look at ways of implementing these findings.

In conclusion, Gibbs Reflective Cycle (1988) has proven an effective tool in encouraging critical reflection and highlighting the importance of reflective practice to promote personal growth and development; I look forward to continuing this practice in future academic and professional endeavours.

Part Two

The Assignment

What is the impact of hormone fluctuation on the perimenopausal voice, and are current management strategies fit for purpose?

This Literature Review is a desk-based study that seeks to identify and examine the symptoms of perimenopause and the effects of hormonal fluctuations on the voice. It also considers the implications of the ageing process on the perimenopausal voice and discusses current methods of measurement and intervention.

This will form the basis of further research into best practices for maintaining optimal vocal health during perimenopause and beyond.

What is Perimenopause?

Perimenopause is the transitional period leading up to menopause, during which a woman's body undergoes significant hormonal shifts, primarily a decrease in oestrogen and progesterone levels (Smith, 2010). It is typically characterised by menstrual irregularity, vasomotor symptoms, sleep disturbances, urogenital symptoms, a decrease in bone mineral density (osteoporosis), and an increased risk of cardiovascular disease. (DHasleer 2009)

According to NHS Scotland, common psychological symptoms can include low mood, anxiety, mood swings, low self-esteem and problems with memory or concentration. Physical symptoms manifest as hot flashes, difficulty sleeping, palpitations, headaches and migraines, muscle aches and joint pains, changed body shape and weight gain, skin changes, reduced sex drive, vaginal dryness and pain, and recurrent urinary tract infections (NHS, 2023). Symptoms relating to vocal complications are not mentioned on this webpage. Further analysis of webpages designed to provide information for women seeking information on perimenopausal symptoms returned no data on the possibility of vocal complications during this time.

This transitional period varies for each individual but can last anywhere from 2 to 10 years prior to menopause, which is defined as the permanent cessation of menstrual periods for at least twelve consecutive months (Hess, 2008). The average age of menopause is currently cited as 51 years (Harper et al., 2022). However, this may vary according to race and ethnicity (Harlow, 2002).

Early menopause may also occur in a number of females due to other health conditions, cancer treatment, surgical intervention or lifestyle choices (Mayo Clinic, 2020). Studies reveal that autoimmune diseases such as rheumatoid arthritis and connective tissue disorders, epilepsy, smoking, anorexia, and stress may all be contributing factors in early onset menopause (Gibson et al., 2017; Doria et al., 2014).

In figures published in Local Government Factfiles (2021), it was estimated that there were approximately 13million perimenopausal or menopausal women in the United Kingdom, equating to around one-third of the entire female population (Local Gov Factfile, 2021).

Despite the majority of generalised secondary data omitting any connection between perimenopause and vocal issues, initial analysis of current academic research indicates that voice complications may occur during this period, impacting vocal quality, including timbre and resonance, hoarseness and fatigue, stability, range and control (Bozeman, 2023; Fiuza et al., 2021).

Abibtol et al. (1999) described these symptoms as Menopausal Vocal Syndrome characterised by vocal fatigue, decreased vocal range, a lowering of vocal intensity and loss of timbre in both the spoken and singing voice. The most commonly reported symptoms in the study were dryness, frequent throat clearing, vocal fatigue, roughness, loss of range and deepening of the voice.

Further research suggests that these symptoms are due predominantly to fluctuations in oestrogen and progesterone, two key hormones in the female endocrine system, both of which play a significant role in maintaining vocal health (Zamponin et al., 2021).

It is, therefore, surprising that the possibility of vocal change during this time is not more widely publicised in mainstream literature. This may be due to the complexities of measuring voice change during this time and the varying degree of symptoms and duration of perimenopause between individuals. Comorbidities, the natural ageing process, ethnicity, and lifestyle choices may also influence data on this demographic (Kim et al., 2017), increasing the complexity of obtaining reliable, accurate data.

Significantly, some women may not experience any vocal change during this time (Titze, 2010). With this in mind, it may simply be easier to omit information from mainstream literature, allowing women with vocal complaints to be proactive and seek out relevant data. The lack of mainstream information may also be simply the result of a lack of recent evidence-based data on the subject matter and the size of the studies currently available.

To comprehend the impact of Perimenopause on the voice, it is, therefore, necessary to gain an understanding of the role of oestrogen, progesterone and testosterone and the interaction of

these hormones on the female reproductive cycle as according to Abitol et al. (1999), the female voice evolves from childhood to menopause under the varied influences of these hormones.

What is Oestrogen?

Oestrogen is a reproductive hormone that is predominantly produced in the ovaries; however, it is also synthesised in the adrenal glands and other tissues (Mayo Clinic, 2020). It plays a vital role in the development and maintenance of female secondary sexual characteristics such as breast development, growth of pubic and underarm hair, and the widening of the hips (Hoegar et al., 2018). It has also been proven to significantly impact the vocal apparatus, playing a vital role in maintaining the health and elasticity of the vocal folds and influencing vocal fold thickness, mucous membranes, collagen, and muscle mass (Titze et al., 1997).

According to Titze (2008), oestrogen helps regulate mucosal secretions in the vocal folds. This is important for lubricating the vocal folds, preventing irritation, and facilitating smooth vocal fold vibrations during speech and singing. By promoting the mucosal layer's suppleness, oestrogen enables the folds to maintain the moisture and elasticity required for overall health, flexibility and function.

Furthermore, research indicates that oestrogen influences collagen synthesis in the vocal fold tissues, which can affect the composition and biomechanical effects of the lamina propria in the vocal folds. Fluctuations in hormone levels, therefore, have the potential to impact flexibility and elasticity, resulting in vocal change. (Hammond et al., 2000)

Research also indicates that oestrogen improves oxygenation to the vocal folds by enhancing the permeability of blood vessels and capillaries, ensuring that the vocal folds receive sufficient oxygen and nutrients, promoting their overall health and function. (Bozeman et al., 2021)

This data highlights the significant role of oestrogen in regulating mucosal secretions, collagen synthesis and oxygenation, evidencing the importance of the hormone in the maintenance of the overall health, flexibility and function of the vocal folds.

Additionally, circulating oestrogen may also influence muscle mass, including muscles involved in vocal production (Kramer et al., 2005). This is relevant as changes in muscle mass can influence pitch and control of the voice (Karkos et al., 2007).

Santen (1988) also states that oestrogen can prevent the effects of androgens, such as testosterone, which can lower and thicken the voice. This highlights the importance of maintaining a healthy hormonal balance to prevent vocal issues.

As oestrogen levels decline during perimenopause, the body attempts to compensate by increasing FSH and LH levels, which can increase androgen production and decrease estrogen production. These hormonal fluctuations lead to changes in the hypothalamic-pituitary-ovarian axis, which further affects the menstrual cycle and the hormonal balance in the body (Santoro, 2011). These hormonal fluctuations can subsequently lead to significant changes in the vocal apparatus, including marked changes in the mucous membranes that line the vocal tract and swelling of the vocal folds.

Studies confirm that declining oestrogen levels may cause laryngeal tissues to absorb water, causing the vocal folds to swell, blood vessels to enlarge, and vocal fold mass to increase (Emerich, Hoover. Sataloff, 1996).

These changes are further demonstrated in a study by Hamdan et al. (2018), where oedema, thickened mucus, and thinning of vocal folds with atrophic changes were observed on laryngeal video stroboscopy in symptomatic perimenopausal/menopausal women.

These are of particular importance to singers as they may affect clarity and resonance of the voice, impacting performance (Titze, 2000).

Further data analysis by Smith (2010) and Brown et al. (2018) also indicates that lowered oestrogen levels during perimenopause may increase vocal fatigue. This is attributed to the influence of the hormone on muscle tone and lung capacity. This may, however, also be linked to the aforementioned changes in the vocal apparatus, which may result in vocal strain and subsequent fatigue.

What is Progesterone?

Progesterone is a hormone that is primarily produced in the ovaries, specifically in the corpus luteum, which is a temporary endocrine structure that forms in the ovary after ovulation. The corpus luteum secretes progesterone in response to luteinising hormone (LH) released by the anterior pituitary gland. This hormone is produced during the second half of the menstrual cycle and is essential for maintaining the uterine lining in preparation for a potential pregnancy (Speroff et al., 1999).

In a pivotal study by Bozeman et al. (2021), progesterone was found to play a vital role in regulating the effects of oestrogen throughout the body. Additional analysis demonstrated a link between progesterone and the vocal apparatus. It was found to impact the mucous membrane of the vocal folds, encouraging them to slough off. This reduced the secretions of the outer layer of

the vocal folds, making them drier. It was also found to decrease the permeability of the fold capillaries, causing the vocal folds to become swollen.

The study further suggested that progesterone may support the quick responsiveness of the laryngeal muscles, demonstrating the importance of considering the relevance of this hormone in perimenopausal vocal health.

As ovarian function declines in perimenopause, ovulation becomes irregular, disrupting progesterone production, resulting in a decrease in progesterone levels (Burger, 2002). This can alter the intricate balance of oestrogen and progesterone, resulting in symptoms synonymous with perimenopause.

Current research on the effect of declining progesterone on the female voice during perimenopause is limited. This may be due to the symbiotic relationship of oestrogen and progesterone on the voice and the similarities of both hormones on the effects on the vocal folds. It may also be difficult to quantify, with Santoro (2016) acknowledging the complexities of studying the biological mechanisms of these hormones, and Koebele et al. (2016) citing multiple factors such as age, diet, environmental factors, genetic background and overlapping comorbidities as further complexities to systematic evaluation during this time.

Studies by Rannevik et al. (1995) and Burger et al. (2008), however, do indicate that perimenopausal and menopausal women have very low circulating levels of oestrogens (estrone (E1), 17 β -estradiol (E2), estriol (E3)) and progesterone but significantly elevated follicle-stimulating hormone (FSH) and luteinising hormone (LH) levels. Other types of oestrogens, such as 2-hydroxy estradiol and 4-hydroxy estradiol, may also circulate, but levels are generally lower. Further research is required to gain a more comprehensive understanding of this subject matter and the implications on the voice.

Other studies of relevance confirming the effects of progesterone on the voice include Behrman et al. (2015), who confirmed the positive influence of progesterone on the vocal folds in maintaining stability and optimum health and Titze (2017), who demonstrated a correlation between declining progesterone levels in perimenopause and menopause and reduced vocal stability. Titze (2011) further noted the impact of progesterone on vocal tract lubrication, which becomes drier as levels decline, causing the vocal folds to become less flexible and more susceptible to damage. According to Brown et al. (2018), vocal instability may subsequently influence pitch, accuracy and vocal fold closure, particularly during sustained phonation.

This was confirmed in a study by Shankar et al. (2015), who noted that postmenopausal women displayed significantly lower scores on measures of voice quality in comparison to premenopausal women in an investigation into the relationship between menopause and voice quality, suggesting

that it may be due in part to the effects of declining progesterone levels on the larynx, which can cause changes in vocal fold tension and vibration.

Other factors influenced by declining progesterone include respiratory function and breath control (LoMauro, 2018). Decreased progesterone has been linked to a decline in respiratory function, resulting in shortness of breath, wheezing and coughing. As breath control is essential for singers in supporting the voice, any reduction can impact performance.

Additional studies suggest that declining levels of progesterone may also significantly impact mental well-being, causing mood swings, anxiety and depression. (Standevon, 2020). This may also affect the singer's confidence and ability to perform.

Hormone Receptors

The effect of oestrogen and progesterone on voice characteristics is mediated by hormonal receptors within the vocal folds and apparatus (Newman et al., 2000).

These proteins bind to the oestrogen and progesterone circulating in the bloodstream, influencing gene expression and signalling pathways in the cells. This can affect the structural and functional characteristics of the vocal folds.

Oestrogen receptors have been identified in the lamina propria, the tissue layer beneath the vocal fold epithelium (Abibtol, 1999). These receptors enable direct influence by oestrogen on cellular activity and composition in the vocal fold lamina propria, thereby impacting its mechanical properties and subsequently affecting voice quality. Additionally, progesterone receptors have also been found in vocal fold tissues, suggesting the potential for progesterone to influence vocal fold function (Wilson, 2020).

Hormonal fluctuation during perimenopause can disrupt hormone receptors, affecting elasticity and hydration of the folds, which may result in irritation and swelling, contributing to vocal disorders or conditions, such as vocal fold nodules or polyps ((Sataloff, 2018), that may require intervention.

It is evident from this literature that both oestrogen and progesterone play a vital part in vocal health; however, ultimately, it is the overarching balance of oestrogen, progesterone, and testosterone that will determine both general and vocal health during this transitional period. This needs to be considered carefully when considering the most appropriate management strategies.

The Menstrual Cycle

Further information can be gathered on the role of oestrogen and progesterone on the female voice by turning to studies on the menstrual cycle and the voice. These studies offer insight into the impact of hormone fluctuation of both oestrogen and progesterone on the female voice, highlighting the intricate relationship of these hormones on the vocal apparatus.

In an early study by Brodnitz (1972), physiological voice changes were most significant when oestrogen was at its lowest on approximately day 21 of the menstrual cycle.

Research by Reby et al. (2008)) noted voice quality was most acceptable in the middle of the menstrual cycle when the secretion of oestrogen and progesterone was approximately equal. Further study by D'Amelio et al. (2001) highlights vocal change across the different phases of the menstrual cycle during which oestrogen increases and decreases.

During the Follicular Phase (Days 1-13), oestrogen rises leading up to ovulation. According to Titze (2008), improved vocal quality may be observed during this phase due to higher levels of oestrogen promoting increased mucosal viscosity through additional mucus secretion by epithelial cells around the vocal folds and enhancement of the permeability of blood vessels and capillaries in the vocal folds, improving tissue oxygenation.

Welch et al. (2010) reported that singers' vocal quality and production are more effortless and rich during ovulation (days 13-15), which coincides with the highest estrogen levels.

The luteal phase (Days 15-28), characterised by an increase in progesterone levels, which rise and remain elevated until just before the onset of menses, may be associated with reduced flexibility, breathiness, fatigue, hoarseness, intonation problems, and a muffled voice, collectively referred to as "dysphonia premenstrualis." (Baker et al., 2010)

Once women reach the postmenopausal phase, permanent physiological changes in the vocal folds occur. According to Abibtol (1999), these changes may include a thinning of the vocal folds, resulting in decreased vocal endurance and fatigue.

Recent developments in perimenopausal research have confirmed that hormonal fluctuations during the menstrual cycle can profoundly impact a woman's voice quality and production (Behrman, 2020; Sataloff, 2021).

From these studies, one can begin to understand the complexities that arise from the fluctuation of these hormones and the possible vocal issues associated with both increased and decreased levels of oestrogen and progesterone on the perimenopausal voice.

Testosterone/Androgen

The role of Testosterone appears to be overlooked in many studies regarding hormones and the female voice, with research on female hormones traditionally focusing on oestrogen and progesterone, more commonly associated with reproductive health. This may be partly due to the lack of understanding of the underlying mechanisms involved in oestrogen, progesterone and testosterone interplay.

As an additional sex hormone, it is essential in maintaining musculoskeletal health and vascular and brain function (Scott, 2020). It can affect bone density and muscle mass, leading to a possible decline in the structural apparatus of the voice during perimenopause, including muscles and cartilage in the larynx. Cognitive function, mood, and sexual function are also affected (Scott, 2020).

In terms of the voice, testosterone is known to play a crucial role in the growth and development of the vocal folds. As testosterone levels decline through perimenopause, menopause and the natural ageing process, vocal folds become thinner and shorter, resulting in changes to the voice, such as hoarseness or a lower pitch (Titze, 2008). However, Schwartz et al. (2009) state that many common etiologies of hoarseness and voice changes make a causal relationship of testosterone challenging to elucidate. Due to the limitation of evidence-based data, further studies into the actions and effects of testosterone in perimenopausal women are required.

Voice Changes

In a study by Schneider et al. (2004), 46% of women were reported to experience vocal changes during perimenopause and menopause, with 33% associated with vocal discomfort. This includes changes to various facets of voice quality, including timbre and resonance, to hoarseness, fatigue, range, and vocal stability issues (Titze, 2012).

Changes in vocal timbre and resonance during perimenopause can be attributed, in part, to changes in the vocal folds, which become thinner and less flexible. This may alter the way in which the folds vibrate, often resulting in a lighter, breathier timbre in some singers (Arnold et al,

2016). Resonance may also be altered, resulting in differences in the distribution of overtones and harmonics (Smith, 2010), with dryness of the folds also impacting timbre.

Studies in vocal hoarseness and fatigue are relatively limited, with few peer-reviewed articles specifically focused on this area of research. However, Brown et al. (2018) do evidence the relationship between hormonal fluctuation during perimenopause and the incidence of vocal instability, hoarseness and fatigue.

Boulet et al. (1996) also report huskiness, loss of high notes, and reduced flexibility and stability in perimenopausal professional voice users, with more than two-thirds reporting vocal changes around the age of 50 years.

Further complications of fluctuating hormones during perimenopause include instability of the voice (Titze, 2019). According to Johnson (2015), this includes changes in vocal range and control, reductions in vocal control and precision in pitch, and problems with vocal endurance. Further research is required to understand the complexity of the underlying mechanisms involved.

During perimenopause, some female singers may experience issues with vocal control, impacting dynamics and pitch (Wilson, 2020). Hormonal fluctuations can disrupt the coordination of vocal muscles, which are critically important for maintaining accurate pitch and dynamics (Wilson, 2020). The decline in oestrogen and progesterone levels can lead to a thickening of the vocal folds, making it increasingly challenging to produce high notes and achieve vocal flexibility (Smith, 2010, Titze, 2008).

Furthermore, the fundamental frequency may also be affected. Studies undertaken on fundamental frequency and perimenopause/menopause convey conflicting data on whether reproductive hormones are responsible for lower frequency or if the change is simply part of the natural ageing process. Accurate data is difficult to obtain due to other mitigating factors such as chronic or acute illness and environmental factors such as smoking.

Research by Mendez et al. (2010) states that menopause is associated with a decrease in fundamental frequency within the magnitude of 10.1 to 13.4 Hz, with Ives et al. (2014) also corroborating a change in fundamental frequency during this time. Other studies demonstrate little difference in frequency between pre and post-menopausal women. A more recent study by Fillipa (2022) concluded that fundamental frequency reduction may affect women to a different extent, depending on whether they are elite performers or other professional voice users.

Changes in hormone levels can also influence respiratory function, affecting vocal endurance and breath control (Smith, 2010). This can manifest as shortness of breath, difficulty taking deep breaths, or changes in breathing efficiency. Alterations in breathing efficiency can ultimately

impact the breath support used to sustain the voice during longer phrases of phonation, thus impacting performance.

Ojool et al. (2001) noted that although there is a decline in respiratory function with age that is independent of sex, women present with respiratory illness twice as commonly as men, suggesting a link between declining sex hormones.

Hormonal fluctuations can also impact the thickness and elasticity of the vocal folds, potentially resulting in alterations in voice quality and control (Hammerschlag et al., 2019).

The impact of these vocal changes on choral singers can be significant. Alterations in timbre and resonance may affect the choir's balance and blend, resulting in issues with harmony and tuning. Decreased range and control may affect the voice part of the individual, with high notes and consistency of pitch altered. Additionally, the decline in vocal endurance and breath control can make it challenging for the choral singer to sustain longer phrases, impacting the performance and overall quality of the choir.

Physiology of the Voice

To gain a comprehensive understanding of the intricate physiological mechanisms that govern the hormonal impacts on the voice during perimenopause, it is imperative to explore both the fundamental principles of vocal anatomy and physiology, vocal techniques and the effect of the natural ageing process on these mechanisms.

Voice production is a complex process involving the interaction of various muscles, tissues and resonating spaces within the vocal tract, culminating in the vibration of the vocal folds responsible for sound production (Titze, 1994). These primary structures are within the larynx and consist of muscles, ligaments, and tissue. The vocal folds come together as air passes through the gap between them, generating vibrations that produce sound. The various aspects of vocal production, such as pitch, volume, and quality, are regulated by muscular adjustments that alter the tension and shape of the vocal folds (Smith, 2010).

According to a recent study by Van Stan et al. (2019), the voice is further shaped by resonating spaces within the vocal tract, including the pharynx, oral cavity, and nasal passages. These spaces modify the sound produced, affecting the quality and timbre of the singing voice.

Characteristics of Speech, as discussed by Kent (1997), include:

- voice (audible sound waves)

- pitch (rate of vibration of the vocal folds)
- resonance (quality and depth in voice)
- intonation (variation of the pitch without distinguishing words)
- tone (pitch variation with distinguishing of words)
- intensity (pressure of sound)
- timbre (characteristic tone or quality)
- articulation (production of vowels and consonant sounds)

The primary physiological difference between singing and speaking in females lies in the way the vocal folds are used, and the control exerted over pitch, intensity, and resonance.

By understanding the different ways pitch, intensity, resonance, articulation and breath control are achieved during speech and singing, one can begin to comprehend the impact of hormone fluctuation on these mechanisms, which may include changes in pitch, intonation, resonance, intensity and overall voice quality. This, in turn, can influence suitable management strategies.

Impact of Ageing on the Voice

Ageing is a natural process that can significantly impact the vocal apparatus, which should be considered when assessing the perimenopausal voice. As the body ages, the vocal folds become less elastic and more fibrous, leading to changes in vocal range quality and control. This may be partly due to a decrease in the amount of collagen in the vocal folds, which can lead to a thinning of the mucosal layer and reduced vocal fold pliability (Titze, 1994).

Additionally, atrophy of the laryngeal cartilage may result in reduced volume and projection of the voice, as well as a thin sound. Vocal endurance and efficiency in muscle coordination may also decrease, leading to pitch inaccuracies, rough or hoarse vocal sounds, and tremors or shakiness in the voice. Hearing loss may also cause pitch inaccuracy (Titze, 1994, Hansen et al, 2006, Behrman, 2016, Roy et al, 2000).

This is valuable information to consider when addressing concerns in perimenopausal women, as some of the symptoms of hormone imbalance are similar to those of hormone fluctuation. Titze (2021) highlights the importance of awareness of the natural ageing process on the vocal apparatus, as knowledge enables the singer to deal with the effects of vocal change more successfully.

Measuring and Assessing Vocal Change

Measuring and assessing voice problems in perimenopausal women involves a combination of subjective and objective methods to evaluate vocal quality, function, and potential issues. Whilst it is not necessary to fully understand these, singers need to be aware of the available methods to make informed choices.

Common methods include Self-Reports, Voice Handicap Index Questionnaire and Voice-Related Quality of Life Questionnaires. Objective methods include voice recording and analysis, video stroboscopy, aerodynamic measurements, electroglottography, voice fold imaging, and hormone level testing (Titze, 2017). However, access and affordability to these methods may be limited, and some tests may be invasive or unsuitable for some women.

Management Strategies for Vocal Change

When contemplating vocal management strategies for the choral singer during perimenopause, it is prudent to consider a holistic approach including healthcare professionals, speech therapists and vocal coaches that address both physiological and psychological issues such as vocal fatigue, hoarseness, vocal stability and other related symptoms associated with hormonal imbalance, to enable the choral singer to continue performing throughout this transitional period. Choral singing requires a stable, resonant voice that can blend well with other voices, good breath control to support the voice and sustain long phrases of music, ease of range, and a strong, reliable work ethic (Coffin, 2014). If a singer's voice is compromised due to hormonal imbalance during perimenopause and managed incorrectly, the voice may become damaged, rehearsals missed, and the blend of the choir subsequently affected.

Choosing the correct course of treatment or management is, therefore, vital to ensure the longevity of the voice and the choral singer's career.

Vocal Education

From data analysis, it is clear that there is a gap in education and awareness around vocal change during perimenopause, with many women unaware of the potential vocal changes they may experience during this time (Titze, 2006).

Moreover, the lack of mainstream literature pertaining to vocal changes during perimenopause, combined with the possible lack of awareness from healthcare professionals and other specialists, such as vocal coaches, makes the situation even more concerning.

This may be due to the varied severity and length of symptoms regarding the perimenopausal voice, making it challenging to provide blanket information and the level of evidence-based research available.

This area must be addressed to enable women to recognise potential problems and explore appropriate treatment and management strategies. This is compounded by possible societal taboos and stigma surrounding perimenopause and the voice, which may also contribute to a lack of information flow between women. As a result, perimenopausal singers often receive limited information regarding the impact of hormonal changes on the vocal apparatus during this phase and need to seek out their information proactively.

Further research is required to ascertain the most appropriate methods of delivering educational tools and appropriate information to healthcare professionals and women in their early thirties. However, for those in a choral setting, education should extend to choral leaders and choir directors, who can create an open and supportive environment for singers to discuss any vocal challenges they may face due to perimenopause. This enables management to recognise potential problems with their members and provide suitable advice and support, ensuring they are singing the correct voice part and avoiding potential vocal damage through vocal strain.

Updates on vocal change and possible management can be delivered through newsletters, individual vocal tutors associated with the chorus, or verbally during rehearsals.

Explanations of warm-ups may also be discussed during delivery to allow the singer to understand why the exercises have been chosen and what area of the vocal apparatus the exercise benefits.

Hormone Replacement Therapy

Hormone Replacement Therapy (HRT) is often the most commonly used strategy to manage perimenopausal and menopausal symptoms (Santoro, 2015). This involves supplementing hormones to balance the fluctuating levels experienced during the time, which can be tailored to

the individual if required. It does, however, carry potential health risks for a minority of women, which may preclude some from treatment.

The efficacy of HRT in preserving vocal health remains a matter of debate, with limited data available on the subject matter. Many of the studies relate to menopause, with little research on perimenopause, and conclusions are varied.

Lindholm et al. (1997) studied the effect of HRT on postmenopausal fundamental voice frequency and sound pressure level in sustained phonation. They demonstrated that voice change associated with declining oestrogen can be improved with HRT.

Amir (2004) also demonstrated positive effects on voice change in postmenopausal females. In a more recent study by Smith (2010), vocal function and quality were said to be improved by the use of HRT; however, other research suggests that it may have little impact (Roy et al., 2011). Roy et al. (2007) suggested it may even have a negative impact on the menopausal voice, linking it to a decrease in vocal fold mass and increased vocal fold stiffness, resulting in a higher pitch and reduced vocal range.

HRT remains perhaps one of the most easily accessible forms of treatment available to female choral singers during this transitional phase, making it a good option for many. Whilst the efficacy of vocal improvement requires further research, other symptoms that can indirectly impact a singer's performance, such as increased mood, have been evidenced (Benedict et al., 2008).

Other medications, including non-hormonal medications such as antidepressants and other over-the-counter medications, may also be used. However, many of these are not clinically proven.

Other interventions to consider include:

Lifestyle Modification

The vocal apparatus is a complex instrument which has been shown to be affected by various factors such as diet, exercise, hydration, and stress (Titze, 2006).

As choral singers must maintain good physical and vocal health to cope with demanding rehearsal schedules and concert programmes, positive lifestyle modifications may prove beneficial.

Pierce (2017) discusses the importance of maintaining a healthy diet rich in iron and vitamins A, C, and E, staying hydrated and avoiding caffeine and alcohol to keep the vocal folds healthy. The

study also highlights the benefits of regular exercise and stress management techniques for promoting relaxation and improving circulation, which can positively impact vocal health.

Vocal Support

As previously evidenced, hormonal change can affect the voice, making it harder to control during perimenopause.

According to Wilson (2020), vocal coaches can play a vital role in monitoring and adapting vocal techniques to accommodate vocal change, enabling singers to maintain and exert control over the voice preventing damage and weakness.

By seeking professional help, singers can begin to address vocal change with prescriptive singing rehabilitation techniques, develop good vocal habits and techniques, and improve posture, breathing, and vocal projection. These all contribute to a stronger, more confident voice, enabling the singer to participate fully in a choral setting.

Bos et al. (2022) emphasise the significance of vocal exercises, promoting a cross-training approach to preserve vocal agility during perimenopause.

The suggested techniques include singing regularly throughout the entire range, including frequent vocalising on pitches outside of the typical range of the singer's repertoire, exercising the voice in targeted ways to increase or maintain strength and flexibility appropriate to the vocal conditioning and the demands of various styles, and practising repertoire from more than one vocal style or genre.

Appendix 1 illustrates vocal techniques that may be considered for the perimenopausal voice.

These include a number of different evidence-based singing techniques.

that can be used in both individual and group settings.

Breathing exercises should also be included to support the voice and reduce vocal strain.

Exercises can often be too generic in larger choral settings where warm-ups are directed at groups. It is, therefore, important to consider the age profile of the singers when delivering such exercises.

Speech and Language therapists may also advise on vocal change, working with speech and phonation during this time.

Psychological Support

Hormone fluctuation during perimenopause can impact mental health and well-being (Cohen et al., 2013), which may affect confidence when performing in a choir. Psychological support, including counselling, cognitive behavioural therapy (CBT) and other complementary therapies, such as hypnotherapy, may be considered (Freeman et al., 2006).

Multidisciplinary Approach

While HRT and voice therapy are important, a multidisciplinary, personalised approach needs to be considered and made more widely available and accessible to perimenopausal women (Hickey et al., 2019).

Many services are simply unavailable to the vast majority of women in the UK. This may be due to a lack of communication between different healthcare providers in a fragmented healthcare system, systemic barriers such as language barriers and geographic location, and possible funding issues to support collaborative care models.

Conclusion

The initial part of the Literature Review investigated hormonal change during perimenopause and the effect of fluctuating reproductive hormones on the voice.

Data revealed that the balance of these hormones does alter during perimenopause (Titze, 2008), with fluctuations in oestrogen and progesterone levels potentially influencing the health of the vocal folds, impacting vocal timbre, range, control and stamina (Titze, 2000, Sataloff, 2021).

It also illustrated the difficulty in identifying the full impact of each individual hormone on the voice due to the intricate nature of the relationship between oestrogen, progesterone and, to some extent, testosterone (Santoro, 2016).

Whilst data from studies on the menstrual cycle deepened the understanding of the effects of oestrogen, progesterone and testosterone on health and the vocal apparatus (Brodnitz, 1972), further research is required to gain a comprehensive understanding of the interplay of these hormones during perimenopause to determine effective evidence-based management strategies.

The ageing process of the voice was also explored. Peer-reviewed studies revealed a decline in vocal fold elasticity and flexibility. Atrophy of laryngeal cartilage and breathing change were also identified as factors influencing vocal quality (Titze, 1994).

Again, research data considering the perimenopausal voice in conjunction with the ageing voice was limited. This area undoubtedly requires further input and a greater holistic understanding by healthcare professionals and voice coaches to deliver positive results in care.

The majority of data regarding hormonal fluctuation during perimenopause and the voice revealed that individual response is varied. Whilst some women may suffer many symptoms, others may notice little change (Baker, et al, 2016). This was also the case in the ageing process, where symptoms may vary significantly between individuals. Physiological condition was found to have the greatest impact on vocal change. This presents problems when providing blanket information on care during this period, as symptoms vary between individuals. Education around this subject should be made more readily available to increase awareness of potential vocal complications during this time.

Analysis of the literature divulged many methods suitable for measuring and assessing voice problems in perimenopausal women. It did, however, reveal that many of these have limitations due to accessibility and affordability.

It also highlighted the lack of education and awareness around potential voice complications in perimenopause, recognising that several women do not realise that they even have a problem to be assessed (Titze, 2006). Furthermore, several women do not report vocal issues, which can skew available data.

By creating better online awareness and providing front-line healthcare professionals with more in-depth knowledge of vocal complications, more women may receive earlier diagnoses and more appropriate care. Female singers should also be encouraged to proactively seek information about the potential impact of perimenopause on the voice.

Management strategies for vocal change are diverse. These can vary according to the available resources and the individual's circumstances. Data revealed Hormone Replacement Therapy as the most common intervention (Santoro, 2015). Whilst this is widely prescribed, studies on the impact of these drugs on vocal health are relatively small and report conflicting results. The majority of studies, however, do reveal a positive effect on vocal health and, therefore, should always be considered as appropriate treatment in the future.

Further evidence-based research is required into the feasibility and success of other interventions; however, several studies exist on suitable vocal exercises and techniques to increase vocal agility and stamina; inclusion of these exercises has been proven to aid in vocal health and can suitably address the vocal problems identified in the Literature Review (Johnson, 2015). These can be directed by a vocal practitioner but are widely available online, making them more accessible to a larger audience.

The potential implications of these findings extend to several disciplines involved in voice rehabilitation and maintenance, including vocal pedagogy, speech therapy, and hormonal treatment, highlighting the importance of adopting an interdisciplinary approach that involves vocal coaches, speech therapists, and healthcare professionals to adequately address the challenges that women face during the perimenopause phase.

This collaborative approach may, however, be difficult to access due to a lack of communication between different healthcare providers, systemic barriers such as language barriers and possible funding issues to support collaborative care models.

In summary, whilst there appears to be a lack of standardised information on the impact of hormonal fluctuation on the perimenopausal voice, raising public awareness may help to destigmatise the topic and encourage an open dialogue among singers and the healthcare community. This will ensure that adequate information and support are available to address the specific vocal needs of both amateur and professional singers, allowing them to navigate this transitional phase successfully.

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Appendix

Vocal warm-up exercises and techniques for maintaining vocal health

Vocal warm-up exercises are crucial for vocal health during perimenopause. These exercises increase blood flow, improve flexibility, and reduce vocal fatigue, reducing the risk of potential injury (Johnson, 2015).

These are just a small selection taken from various vocal paedagogies.

Breathing Exercises

Practice diaphragmatic breathing by taking slow, deep breaths.

Focus on expanding the lower abdomen during inhalation.

On the out-breath, make a hissing sound to release the air. Wait for a short period to allow for natural inhalation of the next breath.

Lip Trills - This is an excellent exercise to relax and warm up the vocal folds, promoting fold vibration.

Gently blow air through the lips while making a "brrr" or "trill" sound.

Slide up and down the vocal range while maintaining the trill.

Humming - This is, again, very effective in promoting vocal fold vibration and relaxation.

Hum gently on a comfortable pitch.

Gradually increase the pitch range.

Slide between 5ths with glissando. More down in semitones and back up in a comfortable range.

Open the humm to a voiced ah vowel at pitch.

Sirens or Glides - Sirens are a useful exercise in warming up the entire range of the voice.

Start at the lowest comfortable pitch and glide upwards to open up the head voice.

Glide back down to the lowest pitch.

Yawn-Sighs - This exercise helps relieve tension and promote a relaxed voice.

Inhale deeply as if about to yawn.

Exhale slowly with a gentle sighing sound.

Sustained Vowels -

Singing sustained vowel sounds (e.g., "ah," "ee," "oo," "eh," "oh") on comfortable pitches.

Maintain each vowel sound for a few seconds, and then switch to the next.

This can be varied by singing, altering pitch formation

This exercise helps with resonance and vowel clarity.

Scale Exercises - This exercise helps with pitch control, breath support, and vocal flexibility.

Sing a simple major scale or arpeggios on different vowel sounds (e.g., "ah," "ee," "oo").

Semi-Occluded Vocal Tract Exercises - These exercises can improve breath control and vocal fold resistance.

Use a straw or a semi-occluded vocal tract exercise tube to perform vocal exercises. Excerpts of music being studied can be sung through the straw.

Tongue and Lip Exercises - These exercises can help improve articulation and clarity.

Perform tongue twisters and lip trills to increase tongue and lip agility.

Vocal fry - helps to strengthen and coordinate vocal folds.

Create a "creaky" sound by letting the vocal cords slightly come together. Gradually slide up and down your range while maintaining this sound.

Articulation Exercises - These can help maintain vocal precision during perimenopause.

Tongue twisters or articulation exercises to improve diction and clarity in speech.

Staccato Exercises - This exercise helps with precision and control.

Sing short, disconnected notes on a single pitch (e.g., "st-st-st-st").

Phonation and Resonance Exercises

Work on exercises that focus on resonance and vocal quality.

Experiment with different vowel sounds and placements to find the most comfortable and resonant voice.

Cool Down

After the vocal warm-up, perform a gentle cool-down.
Perform some slow and relaxed humming or soft singing to help the vocal folds relax.
It is crucial to prioritise rest and recovery to prevent vocal strain.
Consistency in practising these exercises during Perimenopause is key to maintaining vocal health during this time.

Other exercises, such as Stemple's Vocal Function Exercises (Sauder, 2010), are also suitable for both Perimenopausal and ageing voices.

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