The effect of estrogen and progesterone on sex differences in susceptibility to noise induced hearing loss.

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

in

Occupational Health and Safety

at Massey University, Manawatū, New Zealand.

Renee Adele Hislop

2013

Abstract

There is some evidence suggesting that males and females differ in susceptibility to noise induced hearing loss (NIHL): that is, they differ in NIHL magnitude even when exposed to the exact same noise exposure (1, 2), and that this may be related to the effects of circulating levels of the female sex hormones estrogen and progesterone on the cochlear response to noise (3-8). The main objective of this research was to determine what effect estrogen and progesterone levels had on sex differences in susceptibility to human temporary threshold shift (TTS) and otoacoustic emission (OAE) shift. A secondary objective was to determine whether estrogen and progesterone levels impacted on the prediction of susceptibility to NIHL using measures of auditory physiology: OAE amplitude, efferent suppression magnitude and 4 kHz pure tone audiometry thresholds. Additionally, it was determined whether the female sex hormones acted to influence susceptibility to NIHL via their effect on these measures of auditory physiology or whether hormones acted independently of these effects to influence susceptibility to NIHL.

25 female and 21 male participants aged 18-35 were exposed to a 3 kHz, continuous, pure-tone noise exposure at 100 dB L_{Aeq} for 15 minutes in their right ear. This exposure provided the equivalent energy to an eight-hour continuous A-weighted sound pressure level, $L_{Aeq,8h}$ of 85 dB. To address the main objective TTS, OAE shift and recovery from TTS and OAE shift were compared in males and females. Serum levels of estrogen and progesterone were measured in female participants and correlations were made between these levels and TTS and OAE shift data. To address the second objective correlations were calculated between auditory physiology measures, TTS and OAE shift for males and females as well as between the sex hormones and auditory physiology measures. Additionally, linear regression models were produced to assess the mediating role of the auditory physiology measures on the relationship between hormones TTS and OAE shift.

This research found no difference between males and the entire group of females in susceptibility to TTS, OAE shift or recovery from OAE shift, although females had a slower recovery from TTS. However, when circulating levels of estrogen and progesterone levels were accounted for a sex difference in TTS was apparent. This

difference was driven by a large, significant, negative correlation between progesterone levels and TTS, whereas estrogen had no significant correlation with TTS or OAE shift. However, estrogen mediated different aspects of auditory physiology, whereas progesterone did not. There was no interaction between the effects of estrogen and progesterone on TTS or OAE shift. Additionally, there was a mediating role of some aspects of auditory function on the effects of estrogen on TTS and to a greater degree on OAE shift. However, estrogen itself only had a small non-significant impact on TTS and OAE shift so this suggests that the impact of auditory function and hormones on TTS and OAE shift are independent.

Acknowledgements

I would like to firstly thank all of my participants. Without all their time and effort there would be no data.

Thank you to my supervisor Ian Laird for all your advice and support over the years.

Thank you to David Welch for your statistical advice as well as well as your on-going support of many kinds.

Thank you to my other friends and family for listening and supporting me throughout the process.

Thank you to my audiology department and management at GLCC: Andrea Kelly and Sarah Daye, for allowing me to use your facilities and equipment to perform my research as well as providing me with support and advice.

This research was supported by funding through the grant HRC 08-606 Prevention of NIHL, a joint initiative by the ACC, Department of Labour and the Health Research Council of NZ.

Table of Contents

List of Figures

List of Tables