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Full Length Article

Short-term effects of simultaneous cardiovascular workout and personal music device use on the outer hair cell function of young adults

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ABSTRACT

Background: Recreational noise exposure, including personal music device use (PMD), has become a growing public health concern, as it may potentially result in the development of hearing difficulties.

Objectives: The aim of the study was to determine the differential impact and short-term effects of simultaneous cardiovascular workout and PMD use on the outer hair cell (OHC) function of young adults.

Method: A quantitative research approach was followed. In this study a pre-test post-test approach was used and twelve subjects participated in three 1 h testing conditions with altered variables including: (i) exposure to PMD use in isolation, (ii) exposure to cardiovascular workout in isolation, and (iii) simultaneous exposure to the latter mentioned. Distortion product otoacoustic emissions (DPOAEs) were conducted pre– and post-exposure for each testing condition as primary indicator of cochlear responses. The process consisted of a cycling procedure through the preset stimulus frequency sequence, measuring the $2f_1-f_2$ (75–70 dBSPL) and constructing a plot of DPOAE levels as a function of frequency.

Results: Individual testing conditions did not result in statistically significant changes of the DPOAE response, however a significantly different profile in the DPOAE response level increase/decrease for the higher frequencies (6–8 kHz) was obtained when comparing the different sessions. Exposure to cardiovascular workout condition in isolation indicated a clear trend of an increased DPOAE response level between the pre-exposure and post-exposure testing from 2 kHz to 8 kHz with a maximum increase at 6 kHz. Both the music-only condition and the combined condition resulted in a clear trend of decreased DPOAE response amplitudes between the pre-exposure and post-exposure testing for the higher frequencies.

Conclusion: Findings support the notion of a clear effect of cardiovascular workout with and without music exposure on the OHC function at higher test frequencies, as measured by DPOAEs. Decreased DPOAE amplitudes between 2 kHz and 8 kHz were observed with music exposure and the opposite effect was observed for cardiovascular workout in isolation.

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ABSTRAK

Agtergrond: Blootstelling aan geraas tydens ontspanningsaktiwiteite, soos die gebruik van persoonlike musiektoestelle (PMT), veroorsaak toenemende kommer met betrekking tot moontlike ontwikkeling van gehoorverlies.

Doelwitte: Die doel van die navorsing was om die differensiële impak en korttermyn gevolge van gelyktydige kardiovaskulêre oefening en PMT gebruik op die buitenste haarselfunksionering van jong volwassenes te bepaal.

Metode: Tydens die studie is 'n kwantitatiewe pre-toets post-toets navorsingsbenadering gebruik waartydens twaalf deelnemers blootgestel is aan drie afsonderlike toetsomstandighede van een uur elk: (i) PMT gebruik in isolasie, (ii) kardiovaskulêre oefening in isolasie, en (iii) gelyktydige kardiovaskulêre oefening en PMT gebruik. Distorsieproduk otoakoestiese emissies (DPOAE) is uitgevoer voor– en na blootstelling aan bogenoemde omstandighede as die primêre aanduiding van kogleêre response wat ontlok word deur 'n vasgestelde stimulus frekwensie patroon wat $2f_1 - f_2$ (75–70 dBSPL) meet en voorstel as'n grafiek van DPOAE as 'n funksie van frekwensie.

Resultate: Die individuele toetsomstandighede het in isolasie geen statisties beduidende verskille in DPOAE amplitudes getoon nie. Statisties beduidende verskille in DPOAE amplitudes van die hoë frekwensies (6–8 kHz) is verkry tydens die vergelyking tussen die verskillende toetsomstandighede. Blootstelling aan kardiovaskulêre oefening alleenlik het 'n duidelike tendens van verhoogde DPOAE amplitudes tussen voor – en na blootstelling tussen 2 kHz en 8 kHz, met 'n maksimum by 6 kHz, getoon. Beide die musiek in isolasie en gekombineerde omstandighede het 'n duidelike afname in DPOAE amplitudes tussen voor – en na blootstelling getoon.

Gevolgtrekking: Hierdie bevindinge ondersteun die teorie dat kardiovaskulêre oefening 'n invloed op buitenste haarselfunksionering van hoë frekwensies kan hê, soos gemeet deur DPOAEs in die teenwoordigheid en afwesigheid van musiek. Verlaagde DPOAE amplitudes tussen 2 kHz en 8 kHz is geobserveer tydens musiektoestel blootstelling en die teenoorgestelde effek is waargeneem vir kardiovaskulêre oefening in isolasie.

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1. Introduction

Over the past decade research has emphasized the growing risk of cochlear damage due to recreational noise exposure among young adults (Danhauer et al., 2009). Noise emitting devices such as personal music devices (PMDs) are now more compact and readily available (Danhauer et al. 2009; Haines, Hodgetts, Ostevik, & Rieger, 2012; Hoover & Krishnamurti, 2010; Hodgetts, Szarko, & Rieger, 2009; Punch, Elfenbein, & James, 2011; Sulaiman, Husain, & Seluakumaran, 2014; Shah, Gopal, Reis, & Novak, 2009). PMDs are manufactured to produce output levels up to 110 dBA (Bhagat & Davis, 2008; Keppler, Dhooge et al., 2010, Kumar, Mathew, Alexander, & Kiran, 2009). Due to the availability, capacity and output levels of these devices research was conducted to assess possible effects on OHC functioning and hearing abilities. Keppler, Dhooge et al. (2010) concluded that temporary changes in outer hair cell (OHC) function, measured by otoacoustic emissions (OAEs) after 1 h listening time, indicated potential damaging effects of listening to a PMD. Kumar et al. (2009) reported a negative correlation between distortion product otoacoustic emission (DPOAE) measurements and music levels indicating that DPOAE amplitudes and signal to noise ratios (SNRs) were less significant in subjects who listened to high output music levels. Lastly, Bhagat and Davis (2008) found reduced DPOAE levels following high intensity music levels at 1.4 kHz–6.0 kHz. After a 30 min exposure time period the results indicated that reduced DPOAE levels may precede the progress of music-induced hearing threshold shifts.

Current legislation regarding noise exposure focuses mainly on occupational noise hazards. The allowable listening level is 85 dBA for an 8 h exposure time (National Institute for Occupational Safety and Health (NIOSH, 1998)). These recommendations state that as the sound level increases with 3 dBA, the listening time should be halved. The increase in the duration of listening time alone poses a great threat of OHC damage which can be measured accurately with OAEs (Attias, Horovitz, El-Hatib, & Nageris, 2001; Singh, Saxena, & Varshney, 2009). Recent European standards for PMDs and mobile phones stipulate, however, that all PMDs sold after February 2013 should have a default set volume of 85 dB (http://www.hear-it.org/New-EU-standards-for-personal-music-players-and-mobile-phones).

Although PMDs can be used in several different listening environments, they are often used whilst doing cardiovascular workout. Cardiovascular workout increases blood flow and circulation to organs of the cochlea as well as oxygen

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