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Short Communication

The Influence of Improved Cardiovascular Health on Hearing, Central Auditory Function and Cognition in Older Adults

Hull R *

Department of Communication Sciences and Disorders, Wichita State University, USA

Abstract

Although cardiovascular disease can occur at any age, it is most prevalent in older adulthood. Cardiovascular disease can impact numerous neurological and organ functions in humans, but one of the most interesting and potentially significant is the relationship of cardiovascular disease on hearing, central auditory processing and cognition in older adulthood. In reviewing nearly 90 years of research on the impact of cardiovascular disease on auditory function, the impact of cardiovascular disease not only on the peripheral auditory system but also on central auditory processing (speech understanding) and cognition (higher levels of cortical function, (e.g. thought processing and decision making) in older adults is worth noting. Of importance to audiologists, however, is that improved cardiovascular health has been found to counteract the negative effects of cardiovascular disease on those peripheral and CNS auditory functions.

Keywords: Central auditory processing; Cardiovascular disease; Cognition; Exercise; Older adulthood; Peripheral hearing loss

Introduction

As was stated by [1] for nearly 90 years beginning with the work [2-4] the existence of what appears to be a strong relationship between the health of the human cardiovascular system and the health of both the peripheral and central auditory systems, and including the health of cognitive function into advanced age has been confirmed by a sizeable number of investigators.

The Relationship

The cardiovascular system directly influences the viability of the cochlea and the central auditory system, and if blood supply is restricted, can frequently compound other damaging influences on those systems including noise, injury and disease. The relationship between cardiovascular health, the resulting reduction of blood and nutrient supply to the cochlea and the health of that system has been confirmed by a great deal of research. As referred to earlier, those include among others. Other research on that topic includes work by Jorgensen [5-20] and many others.

As an example, as found in [21,22] conducted an extensive review of related research to determine a possible relationship between chronic cardiovascular disturbance and hearing status. Through those reviews, they found consistency among the various research studies of adults with impaired hearing that those who exhibited cardiovascular disease and signs of peripheral arterial circulation disorders had significantly poorer hearing thresholds between the 500-8000 Hz frequency range compared to other subjects without cardiovascular disease, and felt that it was related to a disturbance of the microcirculation of the cochlea. Of course, there are many possible causes of peripheral hearing loss, but whatever those might be, cardiovascular disease appears to exaggerate the degree of potential impact of those causes, and thus the degree of hearing loss.

Even among younger adults, there seems to be a relationship between early onset arteriosclerosis and changes within the cochlea [23] compared temporal bones of young adult subjects who possessed arteriosclerosis with temporal bones from patients without arteriosclerosis. They found that the temporal bones with generalized arteriosclerosis possessed significantly fewer ganglion cells at the basal turn of the cochlea, along with an atrophic spiral ganglion, which would be expected to be associated with a sensorineural hearing loss. However, audiograms had not been previously obtained on the arteriosclerotic subjects. Other earlier researchers have studied the possible relationship between cardiovascular disease and an increased probability of associated hearing loss, felt that varying degrees of degenerative changes in the cochlea are attributable at least in part to changes in blood supply to the peripheral and central auditory systems over-time. They stressed that any degeneration in the stria vascularis can affect the quality of the endolymph within the cochlear duct, which, in turn, can result in a disruption of the processes by which electrochemical energy is created within the organ of Corti.

In earlier work, confirmed a positive relationship between stria vascularis atrophy and degenerative changes along the basilar membrane which contribute to a decline in electro sensory function of the cochlea. Those authors stressed that the cochlea relies on adequate blood circulation to function appropriately, and any reduction in

***Corresponding author:** Hull R, Department of Communication Sciences and Disorders, Wichita State University, USA Tel: +1 3169783271; Fax: +1 3169783290; E-mail: ray.hull@wichita.edu

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blood supply can result in increased vulnerability to common causes of impaired hearing such as that of noise exposure. Other early work by Fisch [24-28] studied degenerative changes within the internal auditory artery. They correlated the extent of narrowing of the internal auditory artery with atrophy of the spiral ganglion and degree of hearing loss. A close relationship between restriction of blood supply through the internal auditory artery and degree of hearing loss was established.

Combined Peripheral and Central Auditory Involvement

Changes in auditory function as a result of a decline in cardiovascular health does not appear to be confined to the peripheral auditory system and can also involve the central auditory pathways. This, of course, can compound the effects of the sensorineural symptoms of impaired hearing. Here I am referring to factors of central auditory processing at the level of the brain stem and auditory cortex of the brain that can further compound the difficulties the individual experiences in speech understanding. That involves the ability to process and decode the complex phonemic elements that comprise spoken speech with the speed and accuracy that is necessary for speech processing and understanding. Several studies have addressed the relationship between the CNS auditory pathways and cardiovascular health. For example, according to the research reviews by [29-34] , among others have postulated a positive relationship between cardiovascular health and the structure and function of the brainstem auditory pathways and auditory cortex that can certainly compound the speech understanding decline that accompanies a sensorineural hearing loss.

Cognition

Others have studied the relationship between cardiovascular health and cognitive function as associated with aging, and found that the relationship is a generally positive one [35]. Cognitive function involves the processing of the meaning and intent that is derived from what others are saying, problem solving, decision making, higher language processing and other similar executive language-based functions that people are engaged in on a daily basis. Particularly, the study suggests that the impact of age and cardiovascular health on the frontal and pre-frontal areas of the brain can result in those significant changes in language-based cognitive abilities.

The Influence of Cardiovascular Health on Auditory/Cognitive Function

Influence of Aerobic Fitness

Further, according to [36] aerobic fitness tends to spare age-related loss of brain tissue and enhances functional aspects of higher order regions of the central nervous system involved in cognitive behaviors. They state that exercise and dietary management appear as an effective means of counteracting neurological and cognitive decline. According to [37,38] over time, exercise appears to change the number and the health of neurons in the brain stem and brain and how they communicate in positive ways. Further, the authors referenced above and research showed the potential influence of improved cardiovascular health on auditory/language functioning in older adults who also possessed impaired hearing. They concluded that improvements in cardiovascular health, for example, through moderate exercise may lead to improvements in central auditory and cognitive functions in older adults, that is for example, decision making, language processing and speed of auditory processing. Further, all of the authors above concluded that cardiovascular improvements might even "turn back the clock" biologically speaking, and lead to patterns of neurocognitive activation that are more similar to the patterns of young adults".

Conclusion

The improvements referred above could likewise increase speed and accuracy of speech understanding, central auditory processing and higher levels of cognitive functioning in older adults. And, a rather thought provoking relationship would be interesting to investigate. That is, could improved cardiovascular health, therefore, become a new component of a patient's program of aural rehabilitation?

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Conflict of Interest

No conflict of interest exists, nor is intended.

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