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Early life origins of hearing impairment in older people

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Data sharing: Code for replication of the present analyses is available from the corresponding author upon request. Anonymised individual-level data for the English Longitudinal Study of Ageing are available to *bone fide* researchers (https://www.ukdataservice.ac.uk/)

To the Editor:

Hearing loss is a major cause of disability: in people over 70 years of age in the United States and United Kingdom, around two-thirds report some form of hearing loss.[1] The social and health consequences of hearing impairment are as considerable as the economic implications for care. That the most prevalent presentation of hearing impairment, age-related hearing loss, is currently incurable brings into sharp focus the need to identify risk factors for its occurrence.

There is strong evidence that several age-related chronic conditions, particularly cardiovascular disease (CVD), have their origins in early life.[2] A shared etiology between hearing impairment and CVD has been advanced in adults.[3] Also, physical stature (height), which captures exposure to early life psychosocial stress, adversity, somatic illness, and nutrition,[4] reveals an inverse relationship with CVD.[4;5] That a correlate of height, insulin-like growth factor 1 (IGF-1),[6] is central to the optimal development of several organs, including the cochlea, is further reason to anticipate a stature–hearing link. Studies examining this relationship are, however, scarce.

The English Longitudinal Study of Ageing is an on-going, population-representative, open, prospective cohort study of men and women living in England aged ≥50 years at recruitment in 2002 (wave 1).[7] Ethical approval for the study was granted by the National Research and Ethics Committee; all participants provided written consent. To capture any loss of height over time (shrinkage), we used a mean value based on direct measurements at waves 4 (2008) and 6 (2012), and related these to performance on an objective hearing examination at wave 7 (2014). Hearing acuity was quantified with the HearCheck device,[8] a simple, low-cost, handheld appliance which produces a fixed series of six pure tones. With any hearing aids removed, the device was held against the left ear of the participant and they were asked to indicate when a beep became audible for the mid-frequency sound (1 kHz) made at three decreasing intensities (55, 35 and 20 dB HL). The process was repeated for a high frequency (3 kHz) sound, again at three different intensities (75, 55, and 35 dB HL). The test was then re-administered for the right ear. Hearing impairment

was defined as hearing fewer than six tones in the best hearing ear. We assessed covariate data using standard protocols.[7]

In an analytical sample of 4,398 study members, there were 1,682 cases (38%) of hearing impairment. We found evidence of an inverse relationship between height and later hearing impairment, such that taller study members experienced a lower risk (Table). Thus, the age- and sex-adjusted (Model 0) odds ratio for the highest quintile of height relative to the lowest was 0.64 (95% confidence interval: 0.51, 0.79). There was also some evidence of a gradient across the height groups (Table, eFigure 1; http://links.lww.com/EDE/B204). Adjusting for all study covariates (Model 2), which included socioeconomic status, smoking, and IGF-1, had a partial attenuating effect (0.75; 0.59, 0.95).

This inverse height–hearing impairment association is comparable in direction and magnitude to that apparent when CVD is the outcome of interest,[4] and potentially offers some etiological insights into the burdensome disorder of hearing loss. We are aware of only two studies reporting on the relationship between height and hearing impairment or acuity.[9;10] One combined small samples of military conscripts and people occupationally subject to high levels of noise, so offering modest generalizability.[9] In the only general population-based sample of which we are aware,[10] a positive correlation between height and hearing acuity was reported in the UK Biobank study, so supporting our own result. While low height *per se* is of course not a risk factor for hearing impairment, it is more likely that one or more of the characteristics for which it is a proxy – early life diet, illness, social adversity, cognition – has a role. Future research should therefore attempt to relate these individual, prospectively gathered indicators in childhood populations to hearing impairment several decades later.

References

(1) Lin FR, Thorpe R, Gordon-Salant S, Ferrucci L. Hearing loss prevalence and risk factors among older adults in the United States. *J Gerontol A Biol Sci Med Sci* 2011; 66(5):582-590.

(2) Lynch J, Smith GD. A life course approach to chronic disease epidemiology. *Annu Rev Public Health* 2005; 26:1-35.

(3) Fisher D, Li CM, Chiu MS, Themann CL, Petersen H, Jonasson F et al. Impairments in hearing and vision impact on mortality in older people: the AGES-Reykjavik Study. *Age Ageing* 2014; 43(1):69-76.

(4) Batty GD, Shipley MJ, Gunnell D, Huxley R, Kivimaki M, Woodward M et al. Height, wealth, and health: an overview with new data from three longitudinal studies. *Econ Hum Biol* 2009; 7(2):137-152.

(5) Lee CM, Barzi F, Woodward M, Batty GD, Giles GG, Wong JW et al. Adult height and the risks of cardiovascular disease and major causes of death in the Asia-Pacific region: 21,000 deaths in 510,000 men and women. *Int J Epidemiol* 2009; 38(4):1060-1071.

(6) Bray I, Gunnell D, Holly JM, Middleton N, Davey SG, Martin RM. Associations of childhood and adulthood height and the components of height with insulin-like growth factor levels in adulthood: a 65-year follow-up of the Boyd Orr cohort. *J Clin Endocrinol Metab* 2006; 91(4):1382-1389.

(7) Steptoe A, Breeze E, Banks J, Nazroo J. Cohort profile: the English longitudinal study of ageing. *Int J Epidemiol* 2013; 42(6):1640-1648.

(8) Siemens. Your hearing - simplified by HearCheck Screener (https://www.bestsound-technology.co.uk/nhs/equipment/hear-check/ - accessed 5th May 2017).

(9) Barrenas ML, Bratthall A, Dahlgren J. The thrifty phenotype hypothesis and hearing problems. *BMJ* 2003; 327(7425):1199-1200.

(10) Dawes P, Cruickshanks KJ, Moore DR, Fortnum H, Edmondson-Jones M, McCormack A et al. The Effect of Prenatal and Childhood Development on Hearing, Vision and Cognition in Adulthood. *PLoS One* 2015; 10(8):e0136590.

Table. Prospective association of height with hearing impairment: the English Longitudinal Study of Ageing (N=4,398)

	Height quintiles (number of participants)						
	1 (880)	**2 (877)**	**3 (880)**	**4 (880)**	**5 (881)**	**OR per 5 cm height advantage**	**P-value for trend**
Median height, cm (range) – men	164.5 (147.8-167.3)	169.7 (167.4-171.6)	173.4 (171.7-175.1)	177.0 (175.2-179.3)	182.7 (179.4-201.8)	-	-
Median height, cm (range) – women	151.7 (134-7-175.6)	156.8 (154.7-158.6)	160.2 (158.7-161.9)	163.6 (161.9-165.5)	168.2 (165.6-186.0)	-	-
Hearing impaired, % (N)	51.1 (450)	42.9 (376)	35.9 (316)	32.9 (290)	28.4 (250)		
Model 0, OR (95% CI)	1 (ref)	0.87 (0.71, 1.1)	0.72 (0.58, 0.89)	0.72 (0.58, 0.89)	0.64 (0.51, 0.79)	0.88 (0.84, 0.93)	<0.0001
Model 1, OR (95% CI)	1 (ref)	0.93 (0.75, 1.2)	0.79 (0.64, 0.98)	0.82 (0.66, 1.0)	0.76 (0.61, 0.95)	0.93 (0.88, 0.98)	0.01
Model 2, OR (95% CI)	1 (ref)	0.91 (0.73, 1.1)	0.79 (0.63, 0.99)	0.81 (0.65, 1.0)	0.75 (0.59, 0.95)	0.92 (0.87, 0.98)	0.01

Model 0: age (continuous) and sex; Model 1: Model 0 + IGF-1 (nmol/l, continuous), smoking status (never, ex-smoker, current), body mass index (BMI, continuous kg/m2), cognitive function (continuous score), educational level (low, medium, high), physical activity (categorical, 5 levels), self-rated poor health (binary); Model 2: Model 1 + self-rated hearing impairment at baseline. CI indicates confidence interval, OR indicates odds ratio.