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Association between hearing loss and deprivation among Welsh adults: a cross-sectional observational study

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ABSTRACT

Objective To index levels of hearing loss with respect to area-level indices of deprivation in a Welsh population.

Design A cross-sectional observational study of all adults (aged >18) that attended Abertawe Bro Morgannwg University (ABMU) Health Board audiology services between 2016 and 2018. Service access, first hearing aid fitting appointment rates and hearing loss at time of first hearing aid provision were used to index population hearing loss versus area-level indices of deprivation based on patient postcode.

Setting Primary and secondary care.

Participants 59 493 patient entries met the inclusion criteria. Patient entries were grouped by age (18–30, 31–40, 41–50, 51–60, 61–70, 71–80, >80 years) and deprivation decile.

Results The interaction between age group and deprivation decile predicted access rate to ABMU audiology services (b=−0.24, t(6858) = −2.86, p<0.01) with audiology services accessed more frequently by the most deprived versus the least deprived decile in every age group (p<0.05), except the >80 years. First hearing aid fitting rates were highest among the most deprived in the four youngest age groups (p<0.05). Severity of hearing loss at the time of first hearing aid fitting was worse among the most deprived in the five oldest age groups (p<0.01).

Conclusions Hearing health inequalities are prevalent among adults accessing ABMU audiology services. Our findings suggest that deprivation increases the likelihood of developing hearing loss, brings earlier onset of hearing loss and is linked to delays in getting help for hearing problems. However, it is not possible to know the true scale of these disparities without knowing the hearing health of the Welsh adult population including those who do not seek help for hearing problems.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We analysed 137 029 audiology appointments attended by 37 831 patients, representing 1.5% of the adult population of Wales.
⇒ Investigating total service utilisation is a novel approach to index population hearing health needs.
⇒ We analysed first hearing aid provision rates in conjunction with audiometric thresholds at time of first hearing aid provision.
⇒ The use of an area-level deprivation index may obscure individual-level variation in deprivation.
⇒ This study was restricted to individuals that had accessed audiology services, likely underestimating deprivation-related hearing health inequalities.

INTRODUCTION

Hearing loss (HL) is the second-leading cause of years lived with disability globally,[1] with one in five adults in the UK estimated to be living with HL.[2] The effect of untreated HL extends beyond poor speech detection and comprehension, being associated with poorer quality of life, increased depression and anxiety, increased cognitive decline and risk of dementia, and lower workforce productivity.[3–8] The burden of HL, however, is not evenly distributed, with higher rates of HL observed among the most deprived.[9–11] Low socioeconomic status (SES) is a long-standing source of health inequalities in the UK and is known to have a detrimental impact on multiple aspects of health.[12] The relationship between HL and deprivation is complex, bidirectional and influential throughout the life course though 'social causation' and 'health selection' mechanisms.[8 13–17]

The Medical Research Council's National Study of Hearing conducted during the 1980s remains the 'gold standard' for UK HL prevalence data.[18–20] Davis[21] found that age, gender and socioeconomic group have a significant effect on the prevalence of hearing impairment, though the effect of socioeconomic group was stronger for men than for women. Over the last four decades UK Government policies have created safer working environments, promoted healthier lifestyles and behaviours, and gradually decreased the proportion of adults living in poverty.[22–24] What impact (if any) this has had on the prevalence and severity of HL among adults is unknown.

There is a national imperative to complete new epidemiology research to understand the hearing health needs of the present adult population particularly with respect

to hearing health inequalities. Large-scale audiometric studies such as the National Study of Hearing, however, require substantial time and resources (eg, specialist equipment, soundproof facilities and trained staff) meaning that it may never be possible to replicate the National Study of Hearing. Attempts to estimate the prevalence of HL in the UK using biomedical and national survey databases have produced results similar to publications from other high-income countries.[15 25–27] Though such methods typically rely on screening tools that do not accurately record the type or severity of HL potentially underestimating or overestimating prevalence rates. Electronic health records are becoming ever more frequently used in a secondary capacity for research purposes.[28 29] Audiological health records have the potential to complement clinical research by informing population hearing health needs and are an underused resource in audiological research.[30 31] In Wales, the majority of the adult population acquire hearing aids through the National Health Service (NHS), though private dispensers are available nationally.[32] Data routinely collected during NHS audiology clinics may, therefore, reveal unique insights into the wider hearing health needs of service users and further our understanding of HL disease progression.

In this study, we used NHS audiological health records as an efficient and cost-effective means to explore the demographics of HL in the general population. Leveraging service-level hearing healthcare data to understand population-level hearing needs is informative with both scientific and clinical application.[33] Audiology service utilisation and hearing aid (HA) uptake may be informative with respect to population demographics of HL in the UK, as several previous studies indicated that SES does not impact audiology service use and HA uptake in countries with socially subsidised hearing healthcare, including the UK.[34]

This cross-sectional observational study had two objectives: to compare levels of (1) HL (indexed by access to NHS audiology services) and (2) HL severity at first hearing aid fitting according to SES across all adult age groups. Knowing that HL prevalence is inversely correlated with SES, we expected audiology services to be used more by persons living in the most deprived areas. We sought to quantify hearing health inequalities in Wales by observing a large clinical cohort of the adult audiology patients.

METHODS

Eligible population

The audiological health records of adult patients aged >18 years old accessing Abertawe Bro Morgannwg University (ABMU) Health Board audiology services between 1 January 2016 and 30 December 2018 formed the population for this study. The ABMU Health Board provided audiology services for the local authorities of Swansea, Neath Port Talbot, and Bridgend between 2012 and 2019. Service provision across all sites was consistent and audiological health records stored electronically using Auditbase software (Auditdata A/S, Copenhagen).

Patient data were mined using SAP Crystal Reports (V.11.0.0.1282) software. Individual patient data were categorised by age group (18–30, 31–40, 41–50, 51–60, 61–70, 71–80, >80 years) and lower super output area (LSOA) using patients date of birth and postcode, respectively. Wales (population 3.2 million) is divided into 1909 LSOAs based on the Office for National Statistics Census geographies, each LSOA has an average population of 1600 people. Within the ABMU Health Board boundary there are 327 LSOAs. All identifiable information (ie, individual date of birth and postcode) was then removed to anonymise the data. The postcode which defines the LSOA is the residence at the time of the data collection.

Deprivation score

The Welsh Index of Multiple Deprivation (WIMD) is the Welsh Government's official measure of relative deprivation for small geographical areas in Wales.[35] The WIMD ranks all the LSOAs in Wales from 1 (most deprived) to 1909 (least deprived), and then groups the LSOAs into deciles, with decile 1 being the most deprived and decile 10 the least deprived.[35] WIMD rank is calculated using 8 separate domains of deprivation composed of 47 underlying indicator datasets relating to both material and social aspects of deprivation.[36] The WIMD is similar to other UK Indices of Multiple Deprivation though it is not directly comparable as it uses different indices and weighting formulae. A limitation of all Indices of Multiple Deprivation is that they do not provide a measure of the amount of deprivation in any given area, and therefore, cannot be used to compare how deprived one area is to another.

The WIMD is typically updated every 3–5 years and several publications are publicly available. The 2019 WIMD publication was used for this study. Every patient was assigned a WIMD decile according to the LSOA associated with their postcode at the time of the data collection. Some cases will have moved address between the time that they accessed the service and the time of the data collection. It was assumed that the number of cases affected would be small.

Cross-sectional observation

Patients who met the sample criteria were organised chronologically by date of appointment. The sample data were copied to create two identical datasets and processed separately. For the accessing audiology services dataset a patient could be included every year they accessed audiology, the earliest date of access per year for each individual was used and all subsequent points of access within the same year removed. For the first HA fitting dataset, individuals could only be considered to have completed one first HA fitting appointment, any subsequent first HA fitting appointments at later dates were removed. Data were then tallied by age group and LSOA for both datasets. Incidence proportion rates (per 1000 persons) were

calculated for the accessing audiology services and first HA fitting using national population estimates.[37–39]

Accessing audiology services

A patient was considered to have accessed ABMU Health Board audiology services if they attended a scheduled audiology appointment, used a 'walk in' clinic, or were seen by an audiologist providing clinical support for ear, nose and throat clinicians.

First hearing aid fitting

A patient was considered a new HA user if they attended a first HA fitting appointment. For an individual within the ABMU Health Board boundary to be provided an NHS hearing aid(s) they must be seen by an ABMU Health Board audiologist and the audiologist must use their clinical judgement to decide whether the patient would gain benefit from a hearing aid(s). There were no formal audiometric criteria for hearing aid(s) eligibility. Any patient without a recent audiogram (within 2 years of fitting appointment) was excluded from the sample.

Hearing impairment at time of first hearing aid provision

Hearing impairment at time of first HA provision was derived from the average of air conduction thresholds at 0.5, 1, 2 and 4 kHz in the better hearing ear measured in dB HL using the audiogram obtained prior to the first HA fitting appointment. Samples with audiogram data for one ear only were excluded (77 cases, 1%).

Analysis and statistical tests

The assumptions of parametric tests were tested for each sample. In any instance of non-normality transformations were explored and equivalent non-parametric tests considered. Normality was assumed for any samples $n \geq 30$ according to the central limit theorem.[40]

Multilevel linear models were constructed to assess whether age group, deprivation decile or the interaction between the two variables are important in predicting access rates to audiology services, first HA fitting appointment rates or better ear average at time of first HA provision. Any variables found to have a significant ($p<0.05$) effect were explored further using appropriate parametric and non-parametric tests.

Parametric testing included the one-way independent analysis of variance (ANOVA) or Welch's F test, depending on whether homogeneity of variance was violated. Trend analysis was completed on any significant ANOVA or Welch's F test results. If the sample data did not meet the assumptions of parametric tests the Kruskal-Wallis test was used in conjunction with the Jonckheere-Terpstra test for trend analysis. All analyses were conducted in R (V.3.6.2).

Patient and public involvement

None.

RESULTS

Study population

There are 327 LSOAs within the ABMU boundary representing all WIMD decile groups. In 2018 the adult (≥18 years old) ABMU population was estimated to be 429 644, representing 17.1% of the Welsh adult population. This study analysed 137 029 audiology appointments attended by 37 831 patients, representing 8.8% of the adult ABMU population. Table 1 compares the distribution of the adult population and LSOAs between WIMD decile groups within the ABMU boundary with that of Wales. The deprivation distribution for the ABMU population is like the general Welsh population, although with a slightly higher proportion of those at the two extremes of deprivation.

Accessing audiology services

There were 59 493 patient entries that met the criteria for the evaluation of access to services. The mean access rate

Table 1 ABMU population characteristics compared with the Welsh population[38]

	Adult population (≥18 years old)		No of LSOAs	
Deprivation (WIMD decile)	ABMU	Wales	ABMU	Wales
1 (most deprived)	44 955 (10.4%)	226 025 (9%)	37 (11.3%)	191 (10%)
2	58 282 (13.5%)	241 373 (9.6%)	46 (14.1%)	191 (10%)
3	49 286 (11.4%)	241 587 (9.6%)	39 (11.9%)	191 (10%)
4	44 875 (10.4%)	248 564 (9.9%)	34 (10.4%)	191 (10%)
5	31 493 (7.3%)	257 357 (10.3%)	24 (7.3%)	191 (10%)
6	27 268 (6.3%)	266 345 (10.6%)	20 (6.1%)	191 (10%)
7	34 128 (7.9%)	263 584 (10.5%)	23 (7.0%)	191 (10%)
8	36 947 (8.6%)	256 673 (10.2%)	26 (8.0%)	191 (10%)
9	45 511 (10.5%)	262 929 (10.5%)	34 (10.4%)	191 (10%)
10 (least deprived)	58 899 (13.7%)	244 409 (9.7%)	44 (13.5%)	190 (10%)
Total	431 644	2 508 846	327	1909

ABMU, Abertawe Bro Morgannwg University; LSOA, lower super output area; WIMD, Welsh Index of Multiple Deprivation.

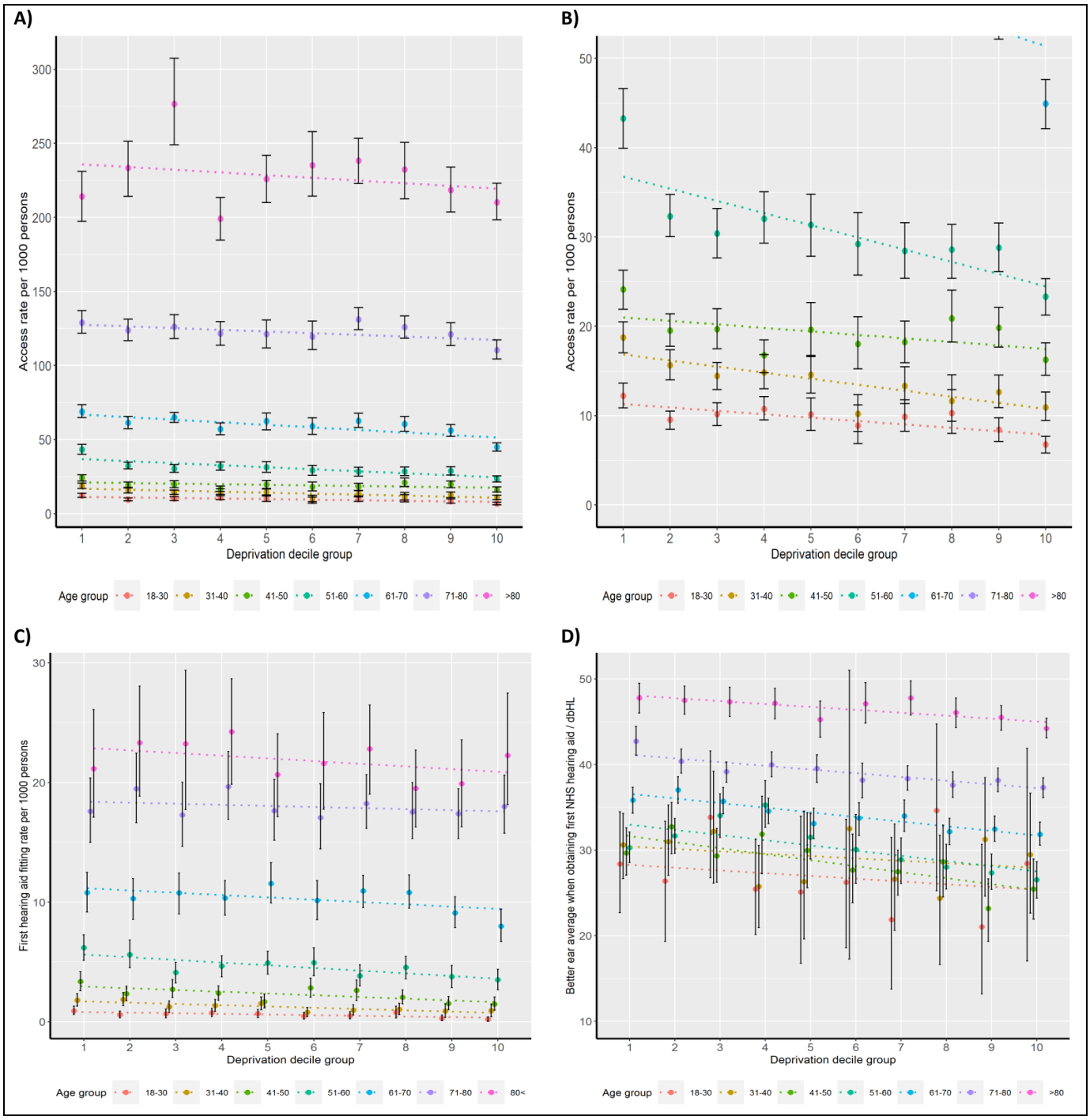

Figure 1 (A) Mean access rate to audiology services per 1000 persons by deprivation decile and age group. (B) Zoomed in section of figure 1A (y axis: 0–50). (C) Mean first hearing aid fitting rate per 1000 persons by deprivation decile and age group. (D) Mean better hearing ear average when obtaining first NHS hearing aid by deprivation decile and age group. All four graphs display linear lines of best fit with 95% CI error bars. Deprivation decile group 1=most deprived, deprivation decile group 10=least deprived. NHS, National Health Service.

between the years 2016–2018 was 69.11 per 1000 persons (95% CI: 67.08 to 71.14). Figure 1A,B illustrates how the access rate means varied by deprivation decile and age group.

Age group predicted access to audiology services, with older groups associated with greater access rate, b=33.83, t(5) = 4.99, p<0.01. Deprivation decile did not predict access to audiology services independently, b=−0.13, t(6858)=−0.35, p>0.05. However, the interaction between age group and deprivation decile did predict access rate, indicating that the effect of deprivation decile on access rate to audiology services depends on age group, b=−0.24,

t(6858)=−2.86, p<0.01. Linear models for each age group revealed that deprivation decile predicted access rate to audiology services in every age group. As deprivation decile increased (less deprived), access rates decreased in every age group except the '>80' group.

First hearing aid fitting

There were 7775 patient entries that met the criteria for the first HA fitting evaluation. First HA fitting appointments accounted for 5.7% of total service utilisation (137 029 appointments). The mean first HA fitting appointment rate between the years 2016–2018 was 8.42 per 1000 persons (95% CI 8.11 to 8.72). First HA fitting appointment rates per 1000 persons varied by deprivation decile in the four youngest age groups (figure 1C). Jonckheere-Terpstra testing revealed linear trends in all four of these age groups; as deprivation decile increased (less deprived) first HA fitting appointment rate decreased.

Hearing impairment at time of first hearing aid provision

There were 7698 patient entries that met the criteria for the evaluation of hearing impairment at time of first HA provision. The mean better hearing ear average at time of first HA provision between the years 2016–2018 was 37.0 dB HL (95% CI 36.8 to 37.4). Better hearing ear average at time of first HA provision (figure 1D) was predicted by age group, b=0.26, t(5) = 7.43, p<0.01, and deprivation decile, b=−0.08, t(7689)=−5.38, p<0.01. This indicates that with increasing age and deprivation, better hearing ear average deteriorated. There was a significant interaction between age group and deprivation with better hearing ear average at time of first HA provision, indicating more severe HL among young, more deprived groups, b=0.01, t(7689)=2.69, p<0.01. Linear models revealed that as deprivation decile increased (less deprived), better hearing ear average decreased in the five oldest age groups explored.

DISCUSSION

This population-level investigation found that (1) NHS audiology service utilisation was higher among the most deprived (except for the very oldest age group), (2) HA provision was higher for the most deprived among the four youngest age groups and (3) hearing impairment was more severe at the time of first HA provision among the most deprived. Previous studies have reported HL being associated with lower SES in the UK.[10 11 21] The findings of this study are novel in suggesting that HL is not only more prevalent but has earlier onset and is more severe among people from more deprived backgrounds. The inequalities observed in this study are likely underestimates of the true extent of SES hearing health inequalities in the general population as specialist outpatient services are typically accessed more by affluent individuals after taking individual health needs into account.[41] In addition, reporting hearing problems is the strongest determinant of seeking help for hearing.[42–44] People from low SES backgrounds, however, tend to under report health conditions,[45] including HL,[41 42] further supporting the pessimistic interpretation of the authors.

Earlier onset of HL in people from more deprived backgrounds

HL with advancing age is common.[46] However, the rate of HL is influenced by factors including unhealthy diet, smoking, excess alcohol consumption, exposure to noise or ototoxic drugs, whereby insults to the auditory system accumulate over time through the life course.[47] As low SES is associated with more frequent unhealthy behaviours that impact hearing, these lifestyle factors may at least partially explain why HL occurs more commonly among low SES groups.[48–51] Our observation that HL is particularly prevalent at earlier ages among low SES individuals is consistent with evidence that deprivation accelerates the ageing process in general, with higher levels of illness and frailty among more deprived people at earlier ages compared with more affluent people.[52 53]

The Welsh government has announced a comprehensive national strategy, supported by legislation, to achieve a fairer society and reduce health inequalities.[54–58] The health impacts of this national strategy are yet to be seen, though addressing the social determinants of poor general health associated with low SES would likely also improve hearing levels. To address hearing health inequalities in the short term, health policies should aim to encourage persons living in the most deprived areas to recognise hearing impairment earlier and report symptoms sooner. Uptake of NHS health screening programmes is historically poor among the most deprived,[59–61] though advances in internet-based testing offers a cost-effective means to improve participation as internet use nears ubiquity in the UK.[62] The method of screening should, therefore, be carefully considered with respect to accessibility and equity if designing an adult national programme for hearing impairment to avoid marginalising the most deprived further. Alternatively, placing hearing services in primary care settings may offer potential for easier access to hearing care. Primary care audiology services have been successfully piloted in Wales and have shown potential to increase accessibility by reducing waiting times and simplifying patient referral pathways, while improving clinical outcomes through earlier intervention.[63 64]

The primary limitation of this study was the use of audiology service utilisation to index population hearing levels. We argue that service utilisation is a valid proxy for population levels of hearing impairment because previous studies suggested that SES is not associated with use of audiology services in the UK.[33] To describe the full extent of the hearing health inequalities observed in this study, one would have to conduct an audiometric survey of hearing levels in a representative population sample.

A second limitation was the use of an area-level index of deprivation as a proxy for individual SES. Several studies have found that area-level and individual-level socioeconomic measurements do not always correlate well with

the socioeconomic characteristics of the individual typically worse than those of the area they live in.[65–67] Despite the potential to underestimate socioeconomic inequalities, area-level deprivation measures have been shown to be a sufficiently valid means of detecting health inequalities when individual-level data are not available.[68 69]

This report focused on one large Welsh health board. Collaboration between the seven Local Health Boards in Wales to produce a report representative of the entire country may reveal further insights about the hearing health needs of adults that are frequently underrepresented in audiology studies (ie, young adults and ethnic minorities, in addition to those from low SES backgrounds).

CONCLUSION

HL is not only more prevalent but occurs at younger age among people from more deprived backgrounds. When they do present at audiology clinics, people from more deprived backgrounds exhibit more severe HL. People from more deprived backgrounds may, therefore, tend to wait longer before seeking help for hearing problems. HL is associated with very large burden due to impacts on quality of life and reduced productivity. People from more deprived backgrounds experience a disproportionate level of burden due to HL. There is an urgent imperative for audiologists and public health policymakers to redress this iniquity.

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Contributors JA acted as guarantor and was responsible for the design, data acquisition, analysis and interpretation of results, and writing of the original manuscript, review and editing. RM contributed to the design of the study, data acquisition, interpretation of results and revision of manuscript. KU contributed to the interpretation of results and revision of manuscript. JJK contributed to the analysis and interpretation of results, and revision of manuscript. PD contributed to the interpretation of results and revision of manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This cross-sectional observational study was completed within routine clinical auditing procedures and considered non-research when approved by the ABMU Health Board Joint Study Review Committee on 3 October 2018.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

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