Literacy skills of Australian Indigenous school children with and without otitis media and hearing loss

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Abstract

This study examined the relationship between reading, spelling and the presence of otitis media (OM) and co-occurring hearing loss (HL) in metropolitan Indigenous Australian children, and to compare their reading and spelling outcomes with those of their non-Indigenous peers. OM and HL may hinder language development and phonological awareness skills, but there is little empirical evidence to link OM/HL and literacy in this population. Eighty six Indigenous and non-Indigenous children attending pre-primary, year one and year two at primary schools in the Perth metropolitan area participated in the study. The ear health of the participants was screened by Telethon Speech and Hearing Centre EarBus in 2011/12. Participants' reading and spelling skills were tested with culturally modified subtests of the Queensland University Inventory of Literacy. Of the 46 Indigenous children, 18 presented with at least one episode of OM and one episode of HL. Results indicated that Indigenous participants had significantly poorer non-word and real word reading and spelling skills than their non-Indigenous peers. There was no significant difference between the groups of Indigenous participants with OM and HL and those with normal ear health on either measure. This research provides evidence to suggest that Indigenous children have ongoing literacy development difficulties and discusses the possibility of OM as one of many impacting factors.

Introduction

The rate of otitis media (OM), an infection where fluid in the middle ear causes neutral or negative pressure (Walker & Wigglesworth, 2001; Williams, 2003), in Indigenous Australian children far exceeds that of their non-Indigenous peers (Kamien, 1975; Nienhuys, Boswell, & McConnel, 1994; Thorne, 2004; Williams, Coates, Pascoe, Axford, & Nannup, 2009). OM is considered a global burden but mainly affects children of ethnic minority groups such as children from South East Asia, Western Pacific and Africa as well as Indigenous Australians. Indigenous Australians were listed in a World Health Organization (WHO) report as having the second highest prevalence rate of OM in the world (World Health Organiz ation, 1996). A study of children in Perth, Western Australia identified 30% of 408 school aged Indigenous children as having OM (Timms, Grauaug, & Williams, 2012). The high rates are not a new problem for Indigenous Australians and OM continues to be common in the children of this population despite decades of research into the epidemiology of the disease in Australia (Gunasekera, Morris, McIntyre, & Craig, 2009; Thorne, 2004).

In both Indigenous and non-Indigenous Australians this disease is often accompanied by periods of conductive hearing loss (HL) (Thorne, 2004; Trewin & Madden, 2005; Williams et al., 2009) and is said to adversely affect literacy skills (Winskel, 2010), and overall academic performance (Walker & Wigglesworth, 2001). When combined with other factors of disadvantage such as literacy levels in the home or poor general health (Hutchins et al., 2007), OM and the associated conductive hearing loss in Indigenous Australian children may contribute to poor educational outcomes in this population (Morris, 2007). These outcomes may result from the physical impact of OM on the hearing mechanism, and/or the impact on the development of pre-literacy skills.

Physical impact

OM is episodic, and varies in severity and duration within episodes (Casby, 2001). It is the most common cause of temporary hearing loss in children (Aithal, Yonovitz, & Aithal, 2006; Zumach, Gerrits, Chenault, & Anteunis, 2007). Repeated episodes of OM can have long term effects on the child as repeated damage to the tympanic membrane caused by infection can result in scarring and cause permanent HL (Zubrick et al., 2004). Similarly, there is a correlation between the number of OM incidents in the first few years of life and the child's auditory sensitivity and brain stem integrity (Zumach et al., 2007). It has been suggested that children with OM and subsequent HL are more likely to demonstrate language delay than their normal hearing peers (Roberts, 2002; Shriberg, 2000; Sonnenschein, 2004; Wake & Poulakis, 2004) as a result of HL and disruption to the development of auditory processing skills during an already sensitive period of language development (Roberts, 2002).

Impact on pre-literacy skills

Exposure to speech sounds is integral to future language learning (Nittrouer, 2005). In terms of literacy development, children require an understanding of the internal structure of words (phonological awareness) in order to learn letter sound correspondences and decoding (Juel, 1994). Children who enter school without phonological awareness may be at an immediate disadvantage (Prior, Bavin, & Ong, 2011; Rohl & Pratt, 1995) and children who enter school with limited phonological awareness may continue to be poor readers in year four (Blachman, Tangel, Ball, Black, & McGraw, 1999). Speech sound exposure is reduced when hearing levels are not optimal (Zumach, Chenault, Anteunis, & Gerrits, 2010). Between the age of 2 and 20 years, the average Indigenous Australian will experience 32 weeks of HL because of OM, compared to the two weeks experienced by the average non-Indigenous Australian (Coates, 2002). The majority of these episodes will occur in the years prior to starting school (Thorne, 2004, Williams & Jacobs, 2009). OM and HL therefore may play a role in reducing school readiness in affected children. Indigenous Australian children are

three times more likely to have literacy problems than their peers in early school years (Hewer & Whyatt, 2006). The high rates of OM and HL in Indigenous Australian children may be expected to contribute to deficiencies in the skills required for literacy in this population, and to poor academic outcomes in the long term (Aithal, Yonovitz, & Aithal, 2008; Walker & Wigglesworth, 2001).

The current study focuses on the early school age population. Children who have a history of OM and HL may already be at a disadvantage at this stage of learning, and continued episodes of the disease may add to the disadvantage. Studies on literacy skills, particularly reading, indicate that skills in decoding sounds are essential in the first year of school and if not achieved will lead to reduced reading achievement (Gough & Juel, 1991; Juel, 1994). Since explicit teaching of literacy and pre-literacy skills occurs in the first years of school (Bentin, 1992) factors associated with OM such as absenteeism, pain or hearing loss may interfere with learning during this period. Additionally, the cultural marginalisation which is a part of the historical context of Indigenous Australian children may be a key factor in the poor academic performance of Indigenous children (Mellor & Corrigan, 2004).

Factors of cultural difference may impact on the outcomes of classroom language assessment as well as a poorer language learning experience. It is possible that some of the language experiences, such as a Standard Australian English (SAE) sound repertoire and explicit phonological awareness exposure, needed for success in literacy in the early school years have not been part of the pre-school experience of some Indigenous Australian children (Partington & Galloway, 2005). The learning style of Indigenous Australian children differs from that of their non-Indigenous peers (Simpson, 2005). A study on educational achievement in Indigenous children in Western Australia revealed that the most successful teachers were those who implemented Indigenous interaction styles (Partington & Galloway, 2005/2006). Positive reinforcement, group work, peer tutoring, indirect questioning

(Partington & Galloway, 2005/2006) and play based tasks (Gould, 2008) may be advantageous for Indigenous learning. Equitable education opportunities are hindered by the lack of recognition of Aboriginal English (AE) in the classroom (Simpson, 2005). Up to 90% of Indigenous Australians in major cities report being able to speak English well or very well (ABS, 2006) however this did not discriminate between Standard Australian English (SAE) and the AE dialect. It has been suggested that Indigenous children in Perth speak a light variety of AE (Sharifian, 2005) indicating minor differences to SAE.

A number of Australian publications have discussed and designed policies based on the assumption that "Hearing loss is likely to impact on social and educational well-being" (Couzos, Metcalf, & Murray, 2001, p. 168) and identify OM and subsequent HL as a possible risk factor for language development and learning difficulties (Zubrick et al., 2004). However, there is to date only one study providing evidence that OM and associated conductive HL in Australian Indigenous children lead to difficulties developing reading and spelling. Walker and Wigglesworth (2001) used strict criteria to define OM and compared the phonological awareness, spelling and reading of nine Indigenous children with OM to ten Indigenous children without OM. The children were year one students in metropolitan Sydney. The non-parametric analysis revealed significantly poorer outcomes on all measures in the children with OM. The current study extends the research on the connection between literacy outcomes and OM with HL with a larger population and longitudinal data with more frequent audiometric testing, as recommended by Walker and Wigglesworth (2001). Specifically, the current study addressed the following questions:

1. Is there a significant difference in the literacy outcomes of Indigenous children compared to a non-Indigenous control?
2. Is there a significant difference in spelling outcomes of Indigenous children with OM and HL compared to Indigenous children with neither OM or HL?

3. Is there a significant difference in reading outcomes of Indigenous children with OM and HL compared to Indigenous children with neither OM or HL?

Method

Ethical approval was obtained from the Curtin University Human Research Ethics Committee, the WA Department of Education and the WA Aboriginal Health Ethics Committee. The project was endorsed by the Telethon Speech and Hearing Centre and Derbaarl Yerrigan Health Service.

Participants

Participants were pre-primary, year one or year two students recruited from four schools across Perth. All Indigenous participants (n=46) were identified as Indigenous on school enrolment forms and had participated in the Telethon Speech and Hearing Centre Variety WA Mobile Ear Clinic Screening Program in 2011. An additional 40 non-Indigenous participants were randomly selected to act as a control group. Only non-Indigenous students known to the teacher to be native English speakers were included in the random selection process. A random number generator was used to select non-Indigenous students on the class lists of the same classrooms as the Indigenous participants. For example, if there were four Indigenous students from one classroom, four non-Indigenous students were randomly selected from this classroom. This was to ensure a similar number of participants from the same school and year. The families of these participants were then contacted by the classroom teacher and provide with the information sheet and consent form. Evidence suggests that literacy milestones progress according to year at school (Owens, 2005) therefore participants were matched by school year. Although gender was not controlled during recruitment, the male to female ratio was even (Table 1). All participants provided a completed guardian and participant consent form.

Table 1 about here

Materials

Audiology assessments. The middle ear condition was tested with a GSI 38 Auto tympanometer. A type A, B or C tympanogram was recorded for each ear. A type B tympanogram or the presence of discharge indicated OM. Audiometric screening was conducted with an Amplivox audiometer using tones of 1000Hz and 4000Hz. An average hearing threshold greater than 25db at 1000hz and 4000hz indicated HL. All instruments are calibrated yearly thereby ensuring valid results.

Literacy assessment. As there is no standardised assessment of the phonological awareness skills of Indigenous children, subtests of the Queensland University Inventory of Literacy (QUIL) (Dodd, Holm, Oerlemans, & McCormick, 1996), a test of phonological awareness skills in school aged children, were modified for cultural appropriateness. The current study included the first five items of the non-word reading and non-word spelling tasks from the QUIL and an additional five real word reading and five real word spelling items. Additional target words were randomly selected from the MacArthur Communicative Development Inventory Vocabulary lists (Fenson et al., 1993). These lists consist of words commonly used by children up to 30 months of age, and are likely to be part of a child's vocabulary by the early school years. These words have a similar variety of words structure as the QUIL stimuli, all subtests contain at least one consonant digraph and vowel digraph, all subtests include at least one consonant cluster, with the exception of the real reading stimuli.

A reference group consisting of a cultural consultant, Aboriginal ear health worker, school deputy principal and a speech-language pathologist experienced in Aboriginal education as well as the school Aboriginal and Islander Education Officers were instrumental in the cultural modifications. Modifications considered the participant group's pre-school

experience, learning style and dialectal difference and aimed to address the cultural considerations previously discussed. Modifications included an extended rapport building time, reduced formality of the assessment and the replacement of stimuli considered unfamiliar for Indigenous Australian children. Further modification was based on known phonological characteristics of AE (Butcher, 2008). Words with /h/ in initial position were not used and words with /f/, /v/, or /th/ in any position were not used in tasks where scores were based on correct phonology.

Scoring

The children's word and nonword spelling was scored using the Spelling Sensitivity Scoring Procedure (Masterson & Apel, 2007). Participants' written responses were entered into the program as graphemes that represented the child's attempt to represent phonemes in the target word (e.g., the child's attempt at wump was entered as w u p. Each grapheme was matched to the corresponding segment in the target word. A score of zero was assigned if an attempt to represent a phoneme was not made (e.g., the missing /m/ in *wump*). A score of one was assigned if the sound was spelled with an illegal spelling (e.g., spelling /u/ in *glue* with a single letter e.g., o as this is never used to represent the sound /u/). A score of two was assigned if the sound was spelled legally (e.g., spelling /u/ in *glue* with the letter u as this represents a /u/ sound in other words like *flu* or *unicorn*). Three points were assigned to phonemes represented using the correct target grapheme(s). An element score was derived for each word. This score is calculated by summing all points awarded and dividing by the total number of phonemes in the target words. The Spelling Element Score (SS) is the total element score for the five real words and five non-words. It is suggested that this procedure provides a sensitive measure of spelling ability and allows for a detailed analysis of the children's spelling skills (Williams & Masterson, 2010). The children's word and nonword

reading was scored as correct or incorrect. The Reading Score (RS) is the total correct out of the 10 real and non-words.

Procedure

Audiology assessments. The ear health of the Indigenous participants was tested by Telethon Speech and Hearing Centre staff who have extensive experience and training in Indigenous ear health. All screeners undergo a six monthly practical competency check and have their work reviewed on a regular basis by a clinical liaison officer to ensure reliability and consistency. The Earbus visited the schools each term in 2011 and 2012 prior to the language assessment. If students were not present on the days the Earbus attended their school, they were not screened. Participants in this study were screened between 1 and 5 times. Participants were included in this study if they had at least one episode of OM and at least one episode of HL.

Literacy assessment. Assessment was carried out by the first author, who was blind to the ear health of the children at the time of assessment. Indigenous children are often afraid of drawing attention to themselves and are reluctant to be separated from their peers, a concept called 'shame' (Gould, 2008), therefore an extended rapport building time with a small group was included. During this time the researcher and the children played a group game or read an 'I-spy' style book. The children were assessed in a quiet room adjacent to their classroom and the assessment took approximately 25 minutes to complete. Most sessions were video recorded. Ten randomly selected videos (10% of assessments) were viewed by the second author who was also blind to the ear health of the students. Firstly, this review was to ensure that the procedure, especially the cultural modifications, was being carried out consistently across participants. The second author also scored each participant in the video recordings and results were compared to the scores given by the assessor. Inter-rater agreement was 90%. The two scorers met to discuss the scoring methodology. The

remaining assessment record sheets for all participants were reviewed to ensure that the errors noted were corrected for all participants.

Results

Audiology Assessments

Of the 46 Indigenous children, 28 did not present with OM or HL at any screen. There were 18 Indigenous children who presented with at least one episode of OM or perforated ear drum and at least one episode of HL.

Literacy Assessment

The means and standard deviations for the reading and spelling assessments are provided in Tables 2. A bivariate analysis showed no correlation between gender and SS and RS. Year group and SS and RS were significantly correlated. As expected, the SS and RS were greater in the older year groups. Year group was factored into the analyses as a covariate.

A multi-level mixed effects linear regression model was used to examine between-group differences on the outcome measures. In SPSS version 21 (IBM Corp, 2012) this is the Generalised Linear Mixed Model approach (GLMM). GLMM is a robust analysis that allows for variation in group size as well as nesting of variables like year group within school (Hedeker, 2005). A separate GLMM analysis was run for each of the outcome variables. The first research question is answered within each analysis.

Relationship of OM, HL and Literacy

In order to determine the relationship between literacy outcomes of Indigenous children with and without OM and associated HL the groups were divided into three broad groups; Non-Indigenous participants, Indigenous participants without OM or HL and Indigenous participants with both OM and HL. This third group included all participants that

were recorded with one or more type B tympanogram or perforation and one or more referred audiometry test. See Table 2 for means and standard deviations.

Table 2 about here

Spelling Element Score. After controlling for Year, there was a significant main effect for group (F[2,83) = 12.94, p < .001). Post-hoc least significant difference (LSD) contrasts indicated that the non-Indigenous group had significantly higher SS than both the noOMHL group (t[83] = 4.31, p < .001, η^2= 0.18) and the OMHL group (t[83] = 3.87, p < .001, η^2= 0.15). There was no significant difference between the latter two groups (t[83] = 0.22, p = .828, η^2= 0.001).

Reading score. After controlling for Year, there was a significant main effect for group (F[2,83) = 12.90, p < .001). LSD contrasts indicated that the non-Indigenous group had significantly higher RS than both the noOMHL group (t[83] = 4.57, p < .001, η^2=0.20) and the OMHL group (t[83] = 3.513, p = .001, η^2=0.13). There was no significant difference between the latter two groups (t[83] = 0.33, p = .739, η^2=0.001).

Discussion

This study was designed to explore the literacy skills of Indigenous Australian children in the early school years with particular reference to rates of otitis media (OM) and co-occurring hearing loss (HL). As established in the literature, results reveal high rates of OM and HL and poor literacy outcomes in Indigenous children when compared to their non-Indigenous peers. Comparisons between the groups of Indigenous participants with and without OM and HL did not reveal significant differences in literacy outcomes. While

theories of language development suggest that OM and HL could cause poor literacy, the results indicate that literacy remains poor in Indigenous students without OM and HL.

Rates of Otitis Media and Hearing Loss

Of the Indigenous participants in this study, 39.1% (18/46) presented with OM and HL at least once during the screening period. This is in the vicinity of other studies that report a similar rate of 30% (Timms et al., 2012) and 42% (Williams et al., 2009) in a similar population though in OM only. It might be expected that recording children with both OM and HL would result in a lower rate. Given that the current study measured ear health on up to five occasions, compared to the single screening results reported in previous studies, this increase is expected. The World Health Organization label a disease with a prevalence rate greater than four per cent as a major health problem (WHO/CIBA Foundation Workshop, 1996). Literature suggests that prevalence of OM reduces as children get older (Bluestone, 1998; Williams et al., 2009). It is therefore likely that the children in this study will have experienced an even higher rate of OM episodes in pre-school years.

Literacy Outcomes

A major observation for the current study is the significantly poorer reading and spelling skills of Indigenous children compared to their non-Indigenous peers. Nationally, Indigenous Australian children have had ongoing poor education outcomes (Hughes, 2012; Mellor, 2004). Western Australia has the third largest number of Indigenous students nationally, and in 2011 40% of these students failed the NAPLAN reading tests compared to only 6% of the non-Indigenous students (Hughes & Hughes, 2012). While educational disadvantages appear to be greater for rural and remote Indigenous Australians, the current study supports literature that provides evidence for poor education outcomes in Indigenous Australians living in metropolitan areas (Australian Institute of Health and Welfare, AIHW, 2008).

Relationship of OM and HL with Spelling and Reading Scores

The absence of a significant difference between the spelling and reading scores of Indigenous participants with and without OM and HL is a valuable addition to the small pool of literature on the relationship between the disease and education outcomes. Walker and Wigglesworth (2001) compared the reading and spelling skills of school aged metropolitan Indigenous children without and without OM (n=21) and found significant differences. This may, perhaps, be attributed to the smaller sample size, or to the fact that participants were grouped by ear health status prior to the language assessments. Despite this contrast, a number of international papers have drawn conclusions similar to those of the current study. Roberts (2002) looked at the longitudinal history of OM and HL and found no relationship between OM and academic skills in early school years. The population of the study, similar to that reported here, was a minority group from a low socioeconomic area in North America. Two large scale meta- analyses reviewed international studies designed to explore the connection between language outcomes and OM. One found no association of OM with speech and language abilities and a small negative association with HL (Roberts, Rosenfeld, & Zeisel, 2004). The other also found that groups of children with and without OM were performing at similar levels on language measures (Casby, 2001).

Given the results of these comparison studies it is, perhaps, not surprising that a significant difference was not found. While it is possible that OM and HL are not the cause of poor educational outcomes, it is also possible that they constitute one of a number of factors that collectively contribute to the poor results. Many of these factors are shared in other groups around the world, and are often related to socioeconomic differences. Examples pertinent to Indigenous Australian children are poor quality or absence of childcare, level of parental education (Hewer & Whyatt, 2006), reduced exposure to Australian English prior to school entry (Western Australian Department of Education, 2002), reduced rates of

attendance (Mc Turk, Nutton, Lea, Robinson, & Carapetis, 2008) and attention at school (Williams, 2003) and behaviour problems (Roberts, 2002). Contributing factors could also include disease and health related issues such as the child's systemic reaction to the disease and provision of medication or treatment or nutrition (Casby, 2001; Coates, 2002). Both may affect the length and number of episodes for the child, which in turn may impact on learning outcomes.

The Cumulative Risk/Interaction Model suggests that a variety of risk factors accumulate in childhood (Vernon-Feagans, Hurley, & Yont, 2002). This accumulation of factors, such as HL resulting from OM (Stenton, 2007), can result in varied outcomes for the child. For example, a child exposed to one risk factor, such as minimal parental education, may develop normally but additional factors will place the child at a greater risk of poor outcomes (Stenton, 2007). This model would provide some explanation for the outcomes in this study. OM and HL may be one of many factors contributing to poor literacy skills in Indigenous children. When extracted and analysed as an individual component, the disease does not appear to have an isolated impact on literacy outcomes.

Limitations and future directions

Applied research in the child's natural setting is somewhat limited. Specifically, it is not possible to control all potential confounding variables. The current study addressed a number of factors said to influence poor literacy outcomes in Indigenous Australian children. For example, the literacy assessment used within this study allowed for differences in peer/assessor interaction compared with usual practice and for any dialectal differences (Gould, 2008). These cultural factors are, therefore, not likely to have contributed to the reduced scores. The study was also able to discount gender differences and to account for age differences within the analyses. However, no attempt was made to address the broader factors which may influence educational outcomes. It appears that previous studies have also had

difficulties sourcing information on parent education, literacy exposure prior to school, home attitude and support for education (Roberts, 2002). A large scale study which includes these environmental factors and their effects on school literacy outcomes in Indigenous Australian children would be a valuable addition to the literature. Further work on differences in literacy outcomes for different cultural groups could usefully employ a participation and partnership model so that the research is conducted with, rather than on, Indigenous and minority groups (Health Research Council of New Zealand, 2010).

A second concern for this study is the catchment rate for the audiology screens. The Telethon Speech and Hearing Centre Earbus has a set number of days for attending each school and conducting screens. If a child is absent or non-compliant on the days of screening then there will be no results for them at that screening point. Between February 2011 and June 2012 there were five opportunities for screening. The number of screens per child ranged from one to five. If a child was absent from school on the days of screening and did have OM or HL at the time this would not be recorded. It is therefore possible that the figures underestimate the number of children with ear health problems. In the current study, five students were recorded with ear results at only one screening. A series of post hoc analyses were run excluding these students from the data. These exclusions did not alter the outcomes of the results reported in this paper. Walker and Wigglesworth (2001) screened their participants 12 month prior and immediately prior to language assessments. While the current study had access to more frequent screening, future research may benefit from stricter inclusion criteria ensuring regular and frequent data collection points. The timing of the literacy assessment was flexible and the screener was able to return to the school to complete an assessment if the child was absent on a particular day. An audiology screener allocated to a group of schools may allow for more flexibility and ensure that the maximum number of children are screened each school term.

Thirdly, while all children received the same stimuli for comparison there were a number of minor inconsistencies between the word structure in each subtest. For example, each subtest had a different number of bigraphs and consonant clusters. The real word reading task was particularly different from the other subtests, with two bisyllable words and no consonant clusters. The comparisons of the current study are between participants so will not be affected however future research looking to compare subtests such as real word or non-word reading and spelling ability might look at matching the stimuli more precisely.

Conclusion

In summary, the current study has shown that OM and HL during the first years of school, as variables isolated from other factors possibly influencing literacy, are not associated with poorer literacy results. It has provided evidence for ongoing poor reading and spelling outcomes in metropolitan Indigenous Australian school aged children, however, the role that OM and subsequent HL plays in these reduced rates will require ongoing investigation.

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Appendix

Words used as stimuli for the reading and spelling assessment

Real word Spelling Stimuli
glue
chin
lips
nose
bread

Non-word Spelling Stimuli
dord
lont
sheke
wump
suts

Real word Reading Stimuli
coffee
egg
food
sock
bunny

Non-word Reading Stimuli
acked
slet
bocks
sord
sed

Table 1

Participants in Each School Across Gender, Indigenous Status and Year Group

School	Participants										
	Total	Female	Male	I	NI	Pre-Primary		Year One		Year Two	
						I	NI	I	NI	I	NI
1	42	20	22	23	19	7	7	8	7	8	5
2	2	1	1	2	0	0	0	1	0	1	0
3	28	13	15	13	15	2	4	6	7	5	4
4	14	5	9	8	6	5	3	2	2	1	1
Total	86	39	47	46	40	14	14	17	16	14	10

Note: I = Indigenous Participants, NI = non-Indigenous participants

Table 2

Means and Standard Deviations for the Spelling Element Score (SS) and Reading Score (RS) of Non-Indigenous and Indigenous Participants With and Without Otitis Media (OM) and Hearing Loss (HL)

	Spelling Element Score		Reading Score	
	Mean	Std. Dev	Mean	Std. Dev
Non-Indigenous	18.38	6.11	4.93	3.23
No OM or HL	13.41	7.73	2.32	3.01
Both OM and HL	12.33	8.39	2.22	2.86