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**The Awareness and Attitudes Towards External Auditory Canal Exostosis and its Preventability in Surfers in the UK: A Cross-Sectional Study**

**Morris S., BMedSc.**

**University of Birmingham, UK.**

**Martin T., MBChB, FRC (ORL-HNS), MD.**

**Consultant ENT Surgeon, Worcester Royal Hospital, UK.**

**McCahon D., PhD**

**Clinical Institute of Applied Health Research, University of Birmingham, UK.**

**Bennett S., BMedSc**

**University of Birmingham, UK.**

Corresponding Author: Simon Morris.

143 Warwards Lane, Selly Oak, Birmingham, UK. B29 7QX.

[simonrhysmorris@yahoo.co.uk](mailto:simonrhysmorris@yahoo.co.uk)

FAX: 0121 414 3759

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## **ABSTRACT**

### **Objectives:**

To determine the proportion of UK surfers aware of External Auditory Canal Exostosis (EACE), identify surfer characteristics associated with knowledge of the condition and explore attitudes to earplug use.

### **Methods:**

An online, cross-sectional survey of UK-based surfers.

### **Results:**

86.1% (n=323, 95%CI 82.3-89.3%) of 375 surfers self-reported awareness of EACE. On further investigation of knowledge, 23.4% (n=88/323, 95%CI 19.5-28.0%) had no knowledge of EACE. Predictors of knowledge included: distance from nearest surfing beach (p=0.001) surfing standard (p=0.008), use of earplugs (p=0.024) and positive EACE diagnosis (p=0.009).

### **Conclusion:**

Findings suggest a significant minority of UK surfers have no knowledge of this condition. Knowledge of EACE was significantly associated with earplug use when surfing. Efforts to improve surfers' knowledge are required to enable surfers to better protect themselves, and could reduce the incidence of EACE.

### **MESH Keywords:**

Awareness, Attitude, Cross-Sectional Studies, Ear Canal, Ear Diseases, Ear Protective Devices, Exostoses, General Practitioners, Sports.

## INTRODUCTION

External Auditory Canal Exostosis (EACE), more commonly known as ‘Surfer’s Ear’, is characterised by bony protrusions within the external auditory canal.<sup>1, 2</sup> This abnormal bone growth occurs due to an ‘*evaporative cooling effect*’: consequential hyperaemia and vasodilation after exposure to cold water leading to increased osteoblast activity and hyperostosis near the tympanic ring.<sup>3, 4</sup>

The stage of EACE is directly related to length of time exposed to cold water, with regular exposure increasing the risk of EACE development by 10% per annum.<sup>5-9</sup> In the UK, 500,000 surfers per year are exposed to seawater below 19°C, the critical temperature for EACE development.<sup>10-13</sup>

Estimates suggest that EACE is present in 63% of UK surfers and that 28% are afflicted with symptoms including otalgia, recurrent otitis externa and hearing loss.<sup>14, 15</sup> Surgical intervention is the sole means of restoring auditory canal patency and eradicating these symptoms.<sup>1, 2</sup>

Earplugs limit cold water entry to the ear when surfing and can reduce the incidence of EACE.<sup>16</sup> Despite this, their use is limited amongst surfers, with only 2-15% currently reporting regular practice.<sup>14, 17</sup>

Awareness of EACE’s preventability may influence earplug use amongst surfers and oppose the growing prevalence of this condition,<sup>15</sup> yet there is currently little evidence regarding surfers’ awareness of EACE and attitude to earplugs. One cross-sectional study reported that 60% of surfers were aware of surfer’s ear;<sup>17</sup> however this study was limited to 92 participants; and as such, findings may not be generalisable to surfers across the UK.

This study reports the findings of a cross-sectional survey to determine the proportion of surfers aware of EACE, and establish the levels of knowledge regarding this condition. In addition explores:

- (1) Surfer characteristics associated with knowledge of EACE,
- (2) Attitudes among surfers towards earplug use,
- (3) Favourable means of educating the surfing population.

## **MATERIALS AND METHODS**

### ***Ethical Considerations***

The University of Birmingham Internal Ethics Review Committee approved the study in January 2015.

### ***Study Design***

A cross-sectional survey of UK surfers. A questionnaire was designed to collect data utilising a tick-box format of categorical options and Likert scales, in four sections.

*Section 1 - Surfer Characteristics:* Participants were asked to self-report age, gender, surfing habits and standard using the Hutt Scale (beginner: 1, 2, 3; intermediate: 4, 5; advanced: 6, 7, 8)<sup>19</sup>, earplug use, EACE-related aural symptoms, diagnosis of and past surgical treatment for EACE.

*Section 2 – Awareness and Knowledge of EACE:* The proportion of surfers aware of EACE was assessed using an explicit yes/no question. Those answering ‘yes’ were directed to

consider ten factual statements with a 5-point Likert scale to ascertain participant's EACE 'knowledge'.

*Section 3 – Attitude to Earplugs:* Ten attitude statements with a 5-point Likert scale attempted to explore the barriers felt by participants towards wearing earplugs when surfing.

*Section 4 – Information Provision:* Participants identified the most preferable means for delivery of EACE advice.

The questionnaire was informed by existing literature, lay texts and discussions with surfers and otolaryngologists experienced in EACE. It was piloted with four experienced surfers and amended correspondingly prior to distribution.

### ***Setting***

Data collection occurred between January-April 2015. Links to the online questionnaire were distributed to the member lists of a national surfing organisation (*Surfing Great Britain*), 12 surf clubs from across the UK and in-person to surfers at beaches in South Wales and Devon.

### ***Participants***

Individuals were eligible to participate if they had surfed for >6 months in the UK and were aged  $\geq 18$  years. Participants were informed that submission of a completed questionnaire consented to use of their anonymised data in analysis and publication.

### ***Sample Size***

The only existing survey of surfers' awareness of EACE in the UK estimated a level of awareness of 60%.<sup>17</sup> Based on this, a sample size of 369 was required to detect a 60% proportion aware of EACE, with a 5% margin of error and 95% confidence intervals.<sup>18</sup>

### ***Data management***

The 5-point Likert scale response options for the knowledge and attitude statements were coded from -2 to +2 (strongly agree to strongly disagree). Data generated from these responses was used to calculate a total score out of  $\pm 20$ .

Participants were classified as having a poor knowledge response by scores of -20 to +5 (responding incorrectly to >5 statements), good: +6 to +14 and excellent: +15 to +20. For the purpose of this study, 'Awareness' was considered a positive answer to the initial yes/no question and 'Knowledge' was considered a good or excellent response to the Likert statements. The ten attitude statements categorised participants as having an overall Positive (total attitude score >0), Neutral (=0) or Negative (<0) attitude towards earplugs.

### ***Statistical Methods***

Statistical analysis was undertaken using SPSS version 19.0. Descriptive analysis was undertaken to generate means and standard deviations (SD). Univariate analysis, comprising of Chi-squared and Fisher's exact tests, and multivariate analysis comprising of a binary logistic regression was used to explore relationships between EACE knowledge and surfer characteristics.

## **RESULTS**

### ***Background Characteristics***

402 questionnaires were returned, of which 375 were fully completed and included in the analysis. 303 (80.8%) respondents were male and the mean age of the sample was 34.42

(SD=12.50) (Figure I). 102 participants reported a previous positive diagnosis of EACE; of whom 30 had undergone surgery for EACE.

40.0% (n=150, 95%CI 35.0-44.9%) used earplugs.

### ***Awareness and Knowledge of EACE***

323 (86.1%, 95%CI 82.3-89.3%) individuals self-reported that they were aware of EACE.

Using data derived from the subsequent knowledge Likert statements: 36 of 323 were classified as having a poor knowledge response, 172 good and 115 excellent (Figure II).

Combining those individuals with a 'good' and 'excellent' response to the knowledge statements, 76.6% (n=287 of 375, 95%CI 72.0-80.5%) were classified as having 'Knowledge'. 23.4% (n=88, 95%CI 19.5-28.0%) were classified as having 'No Knowledge', by combining those with no awareness and a 'poor' knowledge response.

There was variability in the proportion of aware surfers who held knowledge, particularly regarding the treatment for EACE: only 35.6% demonstrated knowledge that surgery is required to correct EACE (Figure III).

Univariate and multivariate analysis was performed to identify surfer characteristics associated with 'Knowledge' versus 'No Knowledge'. All independent variables from Section 1 of the questionnaire were tested, controlling for age and gender (Figure IV).

Four independent variables were significantly associated with 'Knowledge' in the multivariate analysis: Hutt Surf Standard (compared to reference Beginner, Intermediate: OR=2.621 p=0.013, and Advanced: OR=3.715 p=0.003), living <5 miles to nearest surfing beach (OR=2.846 p=0.001), being an earplug user (OR=2.367 p=0.024) and positive



diagnosis of EACE (OR=15.837 p=0.009). Experience of clinical symptoms and years surfed were not significantly associated with knowledge.

### ***Attitudes to Earplug Use***

69.6% were categorised as having a positive attitude towards earplugs (Figure V). Three leading barriers to earplugs emerged from the attitude Likert data: 82.4% agreed that earplugs adversely impact hearing, 51.4% that earplugs interfere with the feeling of immersion in the sea and 41.1% that earplugs are uncomfortable. Of the 225 individuals who did not wear earplugs, 56.0% (n=126) said they would use earplugs if they knew more about EACE.

### ***Information Provision***

84.0% (n=315) of all respondents reported that they would benefit from greater levels of surfing-related health advice. Overall, 61.1% of respondents favoured the delivery of surfing-health advice via social media, 9.3% via magazine articles, 8.3% via a medical speaker at surf-club meetings and 5.3% via leaflets at GP surgeries.

## **DISCUSSION**

### ***Synopsis of Key Results***

Findings indicate that 86.1% of surfers are aware of EACE, however further investigation showed that not all 'aware' surfers were necessarily well-informed about EACE's implications. This proportion is greater than Reddy's estimate of 60%,<sup>17</sup> however experienced surfers were predominantly represented in the current study's sample (49.3% advanced).

Presence of symptoms, previous surgery, number of years surfed and employment status were associated with knowledge in the unadjusted analysis, however were not significant

contributors in the multivariate model when the effect of age, gender and all other independent variables were controlled for. The multivariate analysis suggests that surfers who wear earplugs were twice more likely to have knowledge of EACE than surfers who did not (OR=2.37). In addition, those with a diagnosis of EACE were considerably more likely to have knowledge than those without a diagnosis (OR=15.83). This suggests that many surfers may gain knowledge of EACE through interaction with a medical practitioner, rather than from health promotional sources.

Over half of the respondents did not use earplugs (60.0%), however the majority of whom (56.0%) reported that they would use earplugs if they knew more about EACE.

It is possible that surf organisations are currently under-utilised as sources for surfing-health advice. Respondents indicated that more health information would be welcome via several routes, although the most effective means of delivering this is inconclusive. Social media was the most popular amongst the participants (61.1%) and has proven benefits as a health education tool;<sup>20</sup> therefore education via social media through surf schools and organisations of the novice, symptom-free population may be useful to minimise the number developing this condition.

### ***Strengths & Limitations***

This is the largest study of EACE to date. Through both in-person and online recruitment the questionnaire was accessible to surfers across the UK and as such, the findings are likely to be generalisable to the UK's surfing population.

Unlike previous studies, this survey used several questions to assess knowledge of EACE, making this a more robust determination of knowledge level.

Although the aural symptoms self-reported are presumed to be those specified, other otological morbidities may have been misreported by the participants.

### ***Applicability of Study***

Studies have attempted to capture the burden of this disease by examining surfers' ears at various locations worldwide. In Australia, the estimated prevalence of EACE is 30.0%,<sup>21</sup> Japan 59.8%<sup>9</sup> and the Basque Coast 61.0%.<sup>22</sup> Therefore, based on current literature this places the UK's EACE prevalence as the highest worldwide (63.0%).<sup>15</sup> Studies agree that it takes approximately 10 years of surfing, which equates to over 5000 hours, in order to acquire a clinically significant disease.<sup>4, 14, 21-24</sup> Thus, this produces a 10 year lag-phase which may make EACE an increasing part of the future ENT surgeon's workload.<sup>24</sup> Currently in the Royal Cornwall Hospital, an average of 13 EACE operations are completed annually.<sup>15</sup> Over the last 9 years, this represents an average increase of 1.23 operations per year, supporting the 'lag-phase'.<sup>15</sup>

Studies agree that earplugs can reduce need for surgical intervention. In Alexander's cross-sectional study, subjects were less likely to have evidence of EACE if they were regular users of earplugs.<sup>14</sup> Likewise, a 10 year follow-up of post-operative patients showed that earplug use significantly reduced EACE recurrence.<sup>16</sup>

These benefits and the consequences of surfing without earplugs should be recognised by health practitioners, and surfing organisations should appreciate their role in educating individuals about the risk of EACE progression with continued, unprotected surfing.

### **CONCLUSION**

The current findings suggest that a proportion of the UK's surfing community are unaware of EACE. Surfers with knowledge of EACE are more likely to use earplugs. With surfing

becoming an increasingly popular sport in the UK, improved awareness of EACE amongst the currently unaware and undiagnosed populations is likely to be valuable. An educational social media campaign may improve surfers' knowledge of EACE, earplug habits and in turn, the burden of this preventable condition.

[1851 words]

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### **Conflicts of Interest**

None.

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## **SUMMARY:**

- EACE is estimated to affect 63% of surfers in the UK; thus the condition is commonly referred to as ‘Surfer’s Ear’.
- The UK has the highest estimated prevalence of EACE worldwide.
- Evidence suggests that use of earplugs when surfing may prevent growth of exostoses.
- 23.4% of surfers surveyed had no knowledge of this condition.
- Knowledge of EACE was significantly associated with earplug use, surfing to a higher standard, living close to a surfing beach and a positive diagnosis of EACE.
- 84% of surfers reported that they would benefit from improved surfing-related health advice delivery. Social media was seen as a favourable means of delivering health promotion messages.
- Medical practitioners should recognise that individuals presenting with EACE-related symptoms should be made aware of the risk of EACE progression with continued, unprotected surfing.

## Figures

### Figure I

#### Background Characteristics of the 375 Participants

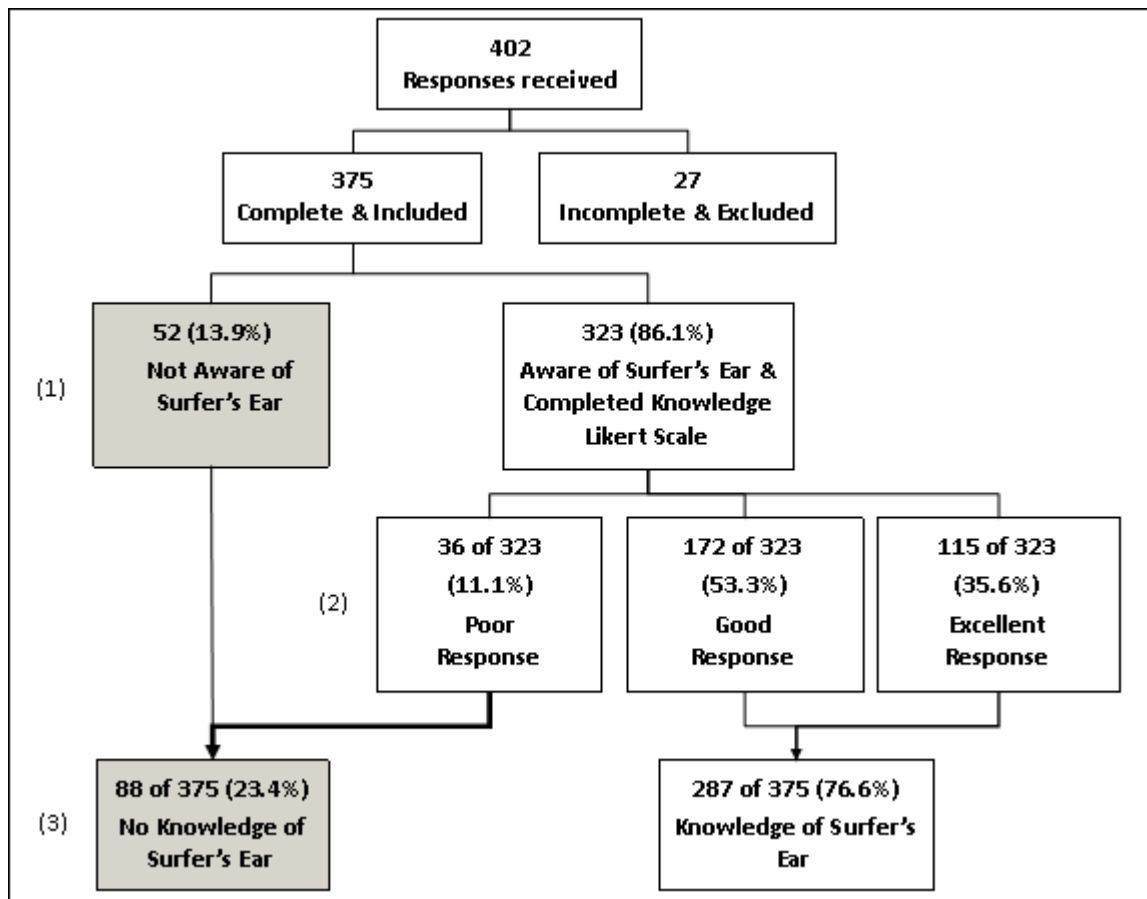
Variables	Total (n=375)
<b>Age</b>	
Mean $\pm$ SD	34.42 $\pm$ 12.50
Range	18-65
<b>Gender</b>	
Male, n (%)	303 (80.8)
Female, n (%)	72 (19.2)
<b>Employment status</b>	
Student, n (%)	87 (23.2)
Employed, n (%)	263 (70.1)
Out of work/Retired, n (%)	25 (6.7)
<b>Hutt Surf Standard</b>	
Beginner, n (%)	83 (22.2)
Intermediate, n (%)	107 (28.5)
Advanced, n (%)	185 (49.3)
<b>EACE Symptoms</b>	
Symptom-free, n (%)	112 (29.9)
Clinically significant*, n (%)	263 (70.1)
<b>GP Diagnosis of EACE</b>	120 (32.0)
<b>Previous Surgery for EACE</b>	30 (8.0)

SD, Standard Deviation. EACE, External Auditory Canal Exostosis

\*Clinically significant symptoms comprise: otalgia, otitis externa, tinnitus and temporary deafness.

**Figure II**

Flowchart of Participation: Outcomes to (1) Awareness Yes/No Question, (2) Knowledge Likert Statement Responses and (3) Binary Knowledge Categories used for Univariate & Multivariate Analysis.



### Figure III

Summary of Responses of the 323 ‘Aware Surfers’ to Knowledge Likert Scale Statements

Knowledge Likert Statement	Summary of Responses, n of 323 (%)	
	Incorrect/Don't Know	Correct
Surgery is the only cure for EACE	115 (35.6)	208 (64.4)
Wind chill does contribute to EACE	91 (28.2)	232 (71.8)
All surfers are at risk of EACE	74 (22.9)	249 (77.1)
EACE can completely close up my ear canal	70 (21.7)	253 (78.3)
EACE is due to cold water exposure	61 (18.9)	262 (81.1)
You cannot see EACE by looking in the mirror	54 (16.7)	269 (83.3)
EACE can be prevented	46 (14.2)	277 (85.8)
EACE is due to bone growth in my ear canal	41 (12.7)	282 (87.3)
EACE features ear infections and hearing loss	32 (9.9)	291 (90.1)
Only long-term surfers get EACE	28 (8.7)	295 (91.3)
EACE, External Auditory Canal Exostosis		

**Figure IV**

Unadjusted and Adjusted Odds Ratios of Surfer Characteristics Predictive of ‘Knowledge’ over ‘No Knowledge’.

<b>Independent Variable</b>	<b>Unadjusted values</b>			<b>Adjusted values (from Binary logistic regression)</b>		
	<b>OR</b>	<b>95% CI</b>	<b>Sig.</b>	<b>OR</b>	<b>95% CI</b>	<b>Sig.</b>
<b>Earplug Use</b>	4.322	2.367-7.892	0.000	2.367	1.122-4.992	0.024
<b>Diagnosis of EACE</b>	14.920	4.599-48.402	0.000	15.834	2.014-24.504	0.009
<b>Surgery for EACE</b>	4.649	1.085-19.920	0.023	9.160	0.748-12.237	0.083
<b>Experience of Clinically significant Symptoms</b>	2.488	1.513-4.092	0.000	1.042	0.563-1.930	0.896
<b>Years surfed: &lt;4 (Reference)</b>				1.000		0.160
<b>Years surfers: 5-14</b>	2.720	1.496-4.945	0.001	1.694	0.784-3.662	0.180
<b>Years surfed: &gt;15</b>	4.954	2.632-9.322	0.000	0.832	0.290-2.391	0.733
<b>Employment: Student (Reference)</b>				1.000		0.203
<b>Employment: Employed</b>	3.968	2.324-6.775	0.000	1.839	0.710-4.763	0.209
<b>Employment: Unemployed</b>	1.994	0.756-5.263	0.174	0.691	0.152-3.139	0.632
<b>Living &lt;5 miles from</b>	4.386	2.544-7.519	0.000	2.846	1.502-5.392	0.001

<b>beach</b>						
<b>Hutt Surf Standard: Beginner (Reference)</b>				1.000		0.008
<b>Hutt Surf Standard: Intermediate</b>	3.051	1.639-5.679	0.000	2.621	1.221-5.267	0.013
<b>Hutt Surf Standard: Advanced</b>	6.552	3.548-12.098	0.000	3.715	1.557-8.865	0.003

Age and gender were controlled for in all variables.

Clinically Significant Symptoms comprise: otalgia, otitis externa, tinnitus and temporary deafness.

EACE, External Auditory Canal Exostosis. Sig., Significance. 95%CI, 95% Confidence Intervals.

**Figure V**

Responses of 375 Surfers to Attitude Likert Scale Statements

