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Healthcare-seeking behaviour and utilization of treatment in a community-based screening study for obstructive sleep apnoea in Busselton, Western Australia

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ABSTRACT

Objectives: To investigate whether in-home screening for obstructive sleep apnoea (OSA) promotes healthcare-seeking or lifestyle modification behaviour. We also examined the uptake and adherence rates to different treatment options, the factors affecting adherence, and the impact of treatment on health-related quality of life.
Design: Follow-up survey of adults at high risk of OSA.
Setting: Community-based sample.
Participants: Adults who completed an in-home sleep study in the 2005-07 or 2010-15 Busselton surveys of adults with apnoea-hypopnoea index (AHI) > 15 (n = 192).
Measurements: The follow-up questionnaire was administered in 2016 and assessed healthcare-seeking and lifestyle modification behaviour, treatment utilization and adherence, and health-related quality of life.
Results: Of the 159 that recalled receiving a result from their in-home sleep study, 65% (n = 103) sought help and/or made lifestyle changes, 49% (n = 78) discussed the results with their GP, 21% (n = 33) underwent a confirmatory study and 33% (n = 53) started treatment. The most common treatment used was continuous positive airway pressure (CPAP) (72%) and adherence rates were high (84%). Self-reported snoring, breathing pauses, daytime tiredness and AHI were identified as predictors of whether people displayed healthcare-seeking behaviour.
Conclusions: This study provides promising evidence that in-home screening for OSA could contribute towards relieving the associated morbidity, especially if health promotion strategies including education are implemented.

Introduction

Obstructive sleep apnoea (OSA) is a prevalent breathing disorder which increases the risk of cardiovascular disease,[1] metabolic dysfunction,[2] and all-cause mortality.[3] A significant proportion of OSA cases in the community remain undiagnosed and untreated.[4–6] OSA screening, although not currently routine,[7,8] has the potential to improve diagnosis and treatment rates, leading to reduced morbidity and mortality from OSA.

Portable monitors are capable of providing an equivalent diagnosis to in-laboratory polysomnography in patients with a high pre-test probability of moderate to severe OSA.[9–11] Portable monitors have also been shown to have high sensitivity and specificity as screening tools in populations that are high-risk according to clinical symptoms, evaluated by sleep specialists, and without comorbid medical or sleep disorders.[10]

Abbreviations: AHI, apnoea-hypopnoea index; BMI, body mass index; CPAP, continuous positive airway pressure; ESS, Epworth Sleepiness Scale; FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; GP, general practitioner; HDL, high density lipoprotein; OSA, obstructive sleep apnoea.

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For screening programs to be effective, the screening tool must have proven efficacy, there should be a defined target population and there should be an accepted treatment.[12] Importantly, patients must also seek further testing and treatment after receiving a positive screening result. To date, only five studies have screened patients for OSA and reported on the proportion that acted on their positive screening result.[8,13–16] The studies reported on either the proportion of patients that consulted a doctor or the proportion that received a confirmatory diagnosis of OSA and results ranged from 18.6% to 80%.[8,13–16] None of the studies reported the proportion that sought help from other sources, such as pharmacists, dentists or the Internet. No studies to date have commented on the factors that are barriers to, or facilitate, further testing and treatment in patients who are found to be high-risk for OSA through screening. However, studies conducted with focus groups and questionnaires have identified some of these factors and barriers in other populations.[17–19]

The gold standard treatment for OSA is continuous positive airway pressure (CPAP).[20] Treatment with CPAP has been shown to improve OSA symptoms and reduce other health risks including cardiovascular disease.[21,22] Other treatment options include weight loss, oral appliances, surgery and positional therapy.[20] The proportion of OSA patients that are treated with each option remains unknown. Despite its demonstrated effectiveness, up to 50% of patients who are recommended CPAP either reject this treatment option or discontinue within the first week.[23] In those that continue therapy, adherence rates range from 29-88%.[24–26] Documented adherence rates with oral appliances range from 48-84%.[27] The barriers and predictors of treatment uptake and adherence are well documented for CPAP,[28,29] but are less well documented for oral appliances.[27] CPAP, oral appliances and surgery have all been shown to improve health-related quality of life, although which is most effective remains controversial.[30–33] While many studies compare the effects on health-related quality of life from two modes of therapy, no single study to date has compared a range of therapies.

The current study is a follow-up survey of a community population in a rural area in Western Australia who had previously screened positive for OSA using portable monitors as part of an ongoing population health survey. The study aimed to investigate whether in-home community screening promotes healthcare-seeking or lifestyle modification behaviour. Qualifying the nature of this behaviour, including further pursuit of diagnostic testing and uptake of treatment or lifestyle modifications, as well as determining what motivated or deterred people from seeking further testing and treatment, particularly in a rural setting, were secondary aims. Another secondary aim was to determine uptake and adherence rates to different treatment options, the factors affecting adherence, and the impact of treatment on health-related quality of life.

Participants and methods

Study design and participants

The Busselton Health Study is an ongoing population health survey of residents in the City of Busselton in the South-West region of Western Australia. The surveys of adults recruit general community samples using the electoral roll for the City of Busselton. Enrollment to vote is compulsory in Australia. This study, conducted in 2016, was a follow-up survey of participants in the 2005-2007[34] and the 2010-2015[35] surveys who undertook in-home sleep monitoring in those surveys and had an apnoea-hypopnoea index (AHI) > 15.

Measures in 2005-2007 and 2010-2015 surveys

Participants in the 2005-2007 and 2010-2015 surveys completed self-administered questionnaires on demography, lifestyle and medical history. Sleep and respiratory symptoms were collected using the Berlin Questionnaire[36] and the 2010-2015 survey also included the Epworth Sleepiness Scale (ESS).[37] In the 2005-2007 survey, single channel (nasal airflow) ApneaLink devices were used and were scored according to default criteria (firmware version 3.49, scoring software version 6.00 Resmed, NSW, Australia). The apnoea hypopnoea index (AHI) was derived from the mean number of apnoeas and hypopnoeas per hour during the evaluation period. All participants were sent a document summarizing their results in the mail. The 2010-2015 survey used a dual channel (nasal flow and oximetry) Apnealink device. Data were scored according to default criteria for this device (version 8) which incorporated a 4% oxygen dip threshold in defining hypopnoeas. Participants were notified of their result by a document summarizing their results in addition to the raw report from the portable device. Participants could choose whether to receive this information through the mail, or discuss their results with a member of the research team. For both the 2005-2007 and 2010-2015 surveys, sleep test scores were categorized as normal (AHI <5), minimal (AHI 6-10), mild (AHI 11-20), moderate (AHI 21-30) and severe (AHI >30). Participants with normal, minimal and mild scores were advised to discuss the result with their doctor if they were experiencing symptoms. Participants with moderate or severe scores were also provided with an information sheet which included information on OSA symptoms, adverse effects on health, causes and treatment, and were advised to visit their doctor for further assessment.

Follow-up questionnaire survey

As there were no known standardized questionnaires that addressed the aims of this study, a set of questions framed round the aims was developed and pilot tested for readability and logic with a convenience sample of adults. The questionnaire comprised items relating to demographics, healthcare-seeking and lifestyle modification behaviour, treatment utilization and adherence, health-related quality of life and the ESS was included (Supplementary material). The questionnaire was developed in both a paper (Cardiff Teleforms) and online format (Qualtrics Survey Software). The mail-out included a postage-paid reply envelope, the 10-page paper questionnaire, a cover letter and a participant information form. Participants were given the option to complete the paper questionnaire or complete the online questionnaire using the URL provided. After six weeks, non-responders were contacted by telephone or email. When telephoned, non-responders were given the opportunity to conduct the survey over the telephone. The email contained the content of the cover letter, including the survey URL, and the participant information form was sent as an attachment. Participants who could not conduct the survey over the telephone were either reminded to complete the questionnaire if they had received it, or another copy was sent to their up-to-date mailing or email address.

Data analysis

All paper questionnaire responses were first entered into Qualtrics and analyses were undertaken using IBM SPSS Statistics Version 4. As all those invited had already participated in the 2005-2007 or 2010-2015 surveys with extensive baseline data available, a comparison of the characteristics of responders and non-responders was conducted using chi-squared tests and t-tests. Four key

outcomes from the follow-up survey were assessed: i) taking any form of action, ii) discussing test results with a General Practitioner (GP), iii) undergoing a confirmatory sleep study and iv) uptake of treatment. Chi-squared tests were conducted on a range of baseline variables collected in the original surveys in addition to new data collected in order to identify predictors of these outcomes. Any potential predictor with a univariate $P < .2$ was then included in two stepwise variable selection logistic regression analyses, one with all predictors in a categorical format and another with continuous variables in a continuous format, in order to identify the primary predictors of the four key outcomes.

Ethics statement

All procedures were approved by the Human Research Ethics Committee at the University of Western Australia (reference: RA/4/1/8039).

Table 1
Baseline characteristics of responders and non-responders

Characteristic		Responders (n = 192)	Non-responders (n = 147)	*P*
Age (years) (mean ± SD)		67.07 ± 9.21	65.69 ± 9.82	.185
Time since original survey (years) (mean ± SD)		5.33 ± 3.05	5.16 ± 2.70	.590
Gender (n (%))	Male	126 (65.6%)	94 (63.9%)	.748
	Female	66 (34.4%)	53 (36.1%)	
Marital status (n (%))	Single	4 (2.1%)	9 (6.1%)	.147
	Married or de facto	162 (84.4%)	121 (82.3%)	
	Widowed, divorced or separated	26 (13.5%)	17 (11.6%)	
AHI value (mean ± SD)		26.35 ± 11.87	27.40 ± 12.46	.661
AHI category (n (%))	Mild (score 16-20)	85 (44.3%)	57 (38.8%)	.582
	Moderate (score 21-30)	54 (28.1%)	44 (29.9%)	
	Significant/severe (score >30)	53 (27.6%)	46 (31.3%)	
Cohort (n (%))	2005-07	58 (30.2%)	40 (27.2%)	.546
	2010-15	134 (69.8%)	107 (72.8%)	
BMI (kg/m^2) (mean ± SD)		29.74 ± 5.25	30.71 ± 5.29	.093
Waist circumference (cm) (mean ± SD)		99.61 ± 13.85	100.96 ± 11.33	.338
Systolic blood pressure (mmHg) (mean ± SD)		136.91 ± 15.57	136.86 ± 15.30	.977
Cholesterol (mmol/L) (mean ± SD)		5.59 ± 1.06	5.24 ± 1.02	.003*
HDL (mmol/L) (mean ± SD)		1.40 ± 0.36	1.32 ± 0.38	.047*
Triglycerides (mmol/L) (mean ± SD)		1.53 ± 0.80	1.62 ± 1.06	.365
Snoring (n (%))	Yes	169 (88.0%)	131 (89.1%)	.754
	No or don't know	23 (12%)	16 (10.9%)	
Self-reported snoring loudness (n (%))	As loud as talking or softer	104 (54.2%)	66 (44.9%)	.212
	Louder than talking	50 (26.0%)	43 (29.3%)	
	Don't know	38 (19.8%)	38 (25.9%)	
Snoring that bothers others (n (%))	Yes	111 (61.0%)	90 (65.2%)	.438
	No	71 (39.0%)	48 (34.8%)	
Fallen asleep driving (n (%))	Yes	25 (13.1%)	20 (13.9%)	.832
	No	166 (86.9%)	124 (86.1%)	
Self-reported snoring frequency (n (%))	Never or almost never	6 (3.3%)	13 (9.2%)	.065
	1-2 times per week or less	43 (23.6%)	24 (16.9%)	
	At least 3-4 times per week	110 (60.4%)	82 (57.7%)	
	Don't know	23 (12.6%)	23 (16.2%)	
Self-reported breathing pauses during sleep (n (%))	Never or almost never	60 (31.9%)	49 (33.8%)	.491
	1-2 times per week or less	34 (18.1%)	18 (12.4%)	
	At least 3-4 times per week	37 (19.7%)	27 (18.6%)	
	Don't know	57 (30.3%)	51 (35.2%)	
Tired after sleeping (n (%))	Never or almost never	65 (34.9%)	71 (48.6%)	.027*
	1-2 times per week or less	73 (39.2%)	40 (27.4%)	
	At least 3-4 times per week	48 (25.8%)	35 (24.0%)	
Tired during wake hours (n (%))	Never or almost never	51 (26.8%)	48 (33.3%)	.203
	1-2 times per week or less	88 (46.3%)	53 (36.8%)	
	At least 3-4 times per week	51 (26.8%)	43 (29.9%)	
Smoker at time of original survey (n (%))	Yes	9 (6.7%)	14 (13.6%)	.077
	No	125 (93.3%)	89 (86.4%)	
FVC (% predicted) (mean ± SD)		97.34 ± 13.40	95.95 ± 11.57	.321
FEV_1 (% predicted) (mean ± SD)		95.59 ± 14.31	95.71 ± 15.10	.939
Employment^ (n (%))	In paid employment or self-employed	86 (64.2%)	71 (66.4%)	.166
	Retired	36 (26.9%)	20 (18.7%)	
	Other (unemployed, unable to work, voluntary work, looking after home/family)	12 (9.0%)	16 (15.0%)	
ESS Score^ (mean ± SD)		6.75 ± 3.92 (n = 134)	6.55 ± 3.84 (n = 107)	.689

AHI = apnoea hypopnoea index. BMI = body mass index. HDL = high density lipoprotein. FVC = forced vital capacity. FEV_1 = forced expiratory volume during first second. ESS = Epworth Sleepiness Scale.

* $P < .05$.

^ Data only available for 2010-2015 cohort.

Results

Sample size and response rate

A total of 109 participants from the 2005-2007 survey and 254 participants from the 2010-2015 survey had an AHI >15 (12.4% of those screened). From these, one had received a diagnosis of OSA prior to undertaking the screening and so was excluded, 11 participants had since deceased and 12 were not contactable, leaving a total of 339 who were invited to participate in the follow-up survey. Questionnaire responses were obtained from 192 (58 from 2005-2007 survey and 134 from 2010-2015 survey), giving a response rate of 56.6%. Of the 147 non-responders, 53 were contacted but declined participation and 92 could not be contacted. The remaining two participants completed questionnaires incorrectly and were unable to be contacted for clarification.

Sample characteristics

Table 1 compares the baseline characteristics of the 192 responders and 147 non-responders. Only cholesterol, HDL, and whether or not participants felt tired after sleeping differed significantly between responders and non-responders.

Thirty-nine percent (n = 74) of responders recalled being notified of their sleep study result by a letter in the mail, 17% (n = 33) recalled being notified by attending an appointment at the study centre and 27% (n = 52) did not recall the method of notification. Seventeen percent (n = 33) of responders did not recall receiving their sleep study results and were not asked further questions, leaving 159 responses for detailed analysis of help-seeking and actions taken (Fig. 1).

Participants that took no action

Forty-four percent (n = 70) reported not seeking any help. Fifty-seven percent (n = 91) did not make any lifestyle changes specifically to address their sleeping. Thirty-five percent (n = 56) did not seek help or make lifestyle changes. The most commonly reported reasons for not taking action or making lifestyle changes were "I wasn't having symptoms so I didn't see the point" (44%), "I didn't think there would be any health consequences if I didn't take action" (28%) and "I didn't think sleep apnoea was a serious condition" (26%). Twenty percent also reported that they did not trust that the results of the home sleep study were an accurate representation of a typical night's sleep.

Actions taken

Of those that recalled receiving a result, 65% (n = 103) sought help and/or made lifestyle changes, 49% (n = 78) discussed the result with their GP, 5% (n = 8) sought advice from a pharmacist, 3.8% (n = 6) sought advice from the internet, 1.9% (n = 3) sought advice from a dentist and 1.9% (n = 3) started treatment without advice from a health professional. The most commonly reported lifestyle change was losing weight (20%) followed by avoiding sleeping in a supine position (18%) and avoiding alcohol and caffeinated drinks before bedtime (15%). The most commonly reported reasons for seeking help and making lifestyle changes were because "I was concerned about the health consequences" (54.6%), "I wanted to treat my snoring" (49.5%), "someone (for example, spouse or friend) said I should" (28.9%) and "I wanted to reduce tendency toward sleepiness by getting diagnosed and getting treatment" (20.6%).

Confirmatory sleep study

Of the 103 responders that took action and/or made lifestyle changes, only 32% (n = 33) went on to have a confirmatory sleep study performed. Of the 78 participants that sought advice from their GP, 40% had a further sleep study, and of those that sought advice from a pharmacist, 25% had a further sleep study. Seventy percent (n = 23) of those that had a confirmatory sleep study organized it through their GP and had it done at a sleep clinic in the closest major town (45 minute drive away). The most commonly reported reasons for undergoing another sleep study were "I was concerned about the health consequences" (60.6%), "a health professional said I should" (48.5%) and "I wanted to address my snoring problem" (42.4%). In 94% of cases (n = 31), OSA was diagnosed on the confirmatory study. The average wait for confirmatory sleep studies was 3.84 weeks. Sixty-three percent (n = 21) reported no barriers to accessing their confirmatory sleep study; 21% (n = 7) reported that the length of the waiting list was a barrier; and 12% (n = 4) reported the distance to the sleep clinic was a barrier. The most commonly reported reasons for not undergoing a confirmatory sleep study were "I thought the result I received from the Busselton Health Study was adequate and didn't feel the need to undergo another sleep study" (44.9%) and "my GP or another health professional thought the sleep study I had was adequate and there was no need for another one" (34.8%).

Treatment

Fifty-three participants (33% of those that recalled receiving their results and 51.5% of those that took action and/or made lifestyle changes) commenced treatment. CPAP was the most used treatment option (71.7%), followed by oral appliances (22.7%), medications (9.4%) and surgery (3.8%). No participants used any other form of positive airway pressure. Table 2 compares the uptake, adherence, troubleshooting, side effects and barriers to access and use of CPAP and oral appliances.

In those that used CPAP, 84% used it for at least 4 hours per night at least 5 days per week while they used it, which is the most widely recognized definition of CPAP compliance.[38] By this definition, 64% of oral appliance users were compliant whilst using the device. Five people reported taking medications (decongestant nasal sprays and drops, steroid nasal sprays, nasal saline lavage and benzodiazepines) to treat their OSA and all were recommended by a doctor (GP or specialist). Two participants underwent surgeries, namely a tonsillectomy and hiatus hernia repair. Three participants used CPAP but could not tolerate it and started using an oral appliance instead.

Of those that only used CPAP as a treatment option, 77% (n = 23) thought the treatment had been effective and of those that only used an oral appliance, 50% (n = 3) thought the treatment had been effective. Table 3 compares the efficacy of CPAP, other treatment and no treatment.

Comparing the ESS scores of the 2010-2015 cohort between the original survey and the current survey revealed a decrease, and hence an improvement in symptoms, in all groups, whether they received treatment or not (Table 3). CPAP treatment resulted in the biggest decrease (2.6 points, $P < .001$), followed by other treatments (0.73 points, $P = .316$) and no treatment (0.5 points, $P = .145$).

Of the 50 responders that did not receive treatment despite seeking help and/or making lifestyle changes, the most common reasons for this choice were "I didn't think sleep apnoea was a serious condition" (34%), "I wasn't having symptoms so I didn't see the point" (34%), "I didn't think there would be any health consequences if I didn't take action" (28%) and "the treatment options were too burdensome and would interfere too much in my daily life" (16%).

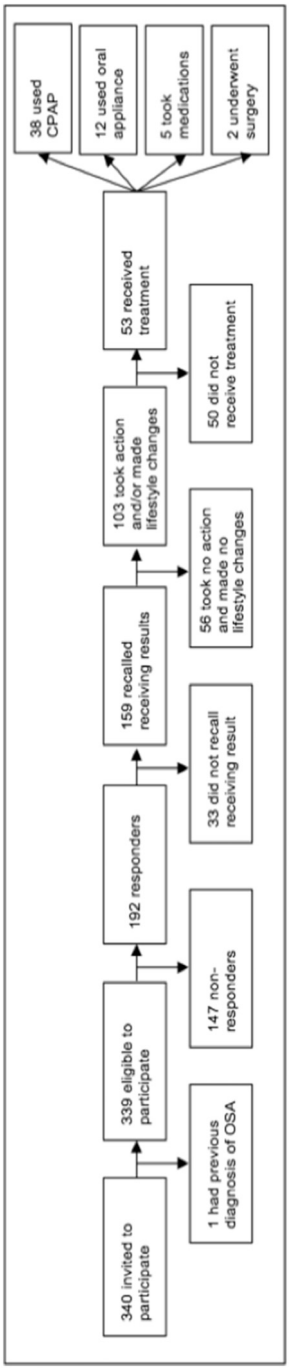

Fig. 1. Diagram showing participant flow throughout the study: Flow depicting the number of participants that responded, recalled receiving their result, took action and received treatment

Predictors of Action

Logistic regression using variables in a categorical format (as per Table 4) identified self-reported snoring which bothers other people and the method of notification of results as primary predictors of taking action (Supplementary Table 1). In the continuous model, AHI was also identified as a primary predictor. The odds of taking action was 2.556 higher in those whose snoring bothered others ($P = .015$). The odds of taking action was three times higher in those that received a letter compared to those that could not recall how they received notification of results ($P = .009$).

Both the categorical and continuous models identified self-reported frequency of breathing pauses as the only predictor of discussing results with the GP (Supplementary Table 2). Compared to those that never or almost never reported breathing pauses, those that reported breathing pauses 1-2 times per week had 3 times higher odds of taking action ($P = .029$) and those that reported breathing pauses 3-4 times per week had 3.5 times higher odds of taking action ($P = .008$).

The two predictors of undertaking a confirmatory sleep study were self-reported snoring loudness and self-reported snoring bothering other people in both the categorical and continuous logistic regression models (Supplementary Table 3). The odds of undergoing a confirmatory sleep study was 3.4 times higher in those whose snoring was louder than talking compared to those whose snoring was softer than talking ($P = .009$), and the odds were 3 times higher in those whose snoring bothered other people ($P = .040$).

Logistic regression using categorical variables identified AHI category (mild, moderate or severe), HDL category (high or low), snoring bothering other people and being tired during wake hours as primary predictors of treatment uptake (Supplementary Table 4). Using the continuous model, the primary predictors were snoring bothering other people, being tired during wake hours, AHI and age. The most substantial predictors from either model were snoring bothering other people (odds of getting treatment 4.8 times higher in those whose snoring bothered others ($P = .002$)), AHI category (odds of getting treatment 4.5 times higher with severe AHI compared to mild ($P = .003$)) and HDL category (odds of getting treatment 4 times higher with low HDL compared to high ($P = .018$)).

Discussion

To our knowledge, this is the first study to examine all the actions people take following a positive OSA screen in a community setting and is the first to comment on the lifestyle actions people take in order to manage OSA. This survey found that in-home screening results in high levels of healthcare-seeking or lifestyle modification behaviour, treatment uptake and compliance with treatment.

In-home screening was successful in promoting healthcare-seeking or lifestyle modification behaviour in 54% of responders and this rate increased to 65% when the participants who did not recall receiving their results were excluded. Considering that consulting a GP was the advice given to participants, it is not surprising this was the most common action taken. The three most prevalent lifestyle changes made by participants (weight loss, sleep posture and avoidance of alcohol before bed) are well recognized management options for OSA,[20] suggesting that people are reasonably well-informed.

These results can be compared to a 2014 study by Fuller and colleagues,[13] who screened people for OSA in pharmacies using a questionnaire and portable monitors. Although the follow-up period was only one year, they found that two-thirds of participants did not recall receiving a referral for further advice regarding identified OSA. This is much higher than in our study where only 17% did not recall receiving a referral, even though the follow-up period was, on average, over five years. They also found that, in those that recalled

Table 2
Comparison of uptake and subjective adherence of CPAP and oral appliances

	CPAP	Oral appliance
Number of participants	38 (71.7%)	12 (22.7%)
Average length of use	3.0 ± 2.2 years	2.2 ± 2.3 years
Average nights used per week	6.4 ± 1.5 nights	5.6 ± 1.9 nights
Average hours used per night	5.9 ± 1.5 hours	5.8 ± 1.5 hours
Troubleshooting		
Help received from equipment provider	30 (79%)	5 (45%)
Help received from healthcare provider	4 (10%)	1 (9%)
Unable to get help despite trying	2 (5%)	2 (18%)
No help required/sought	4 (10%)	4 (36%)
Side effects		
Number who reported side effects	35 (92%)	8 (67%)
Common side effects	"Poor mask fit/discomfort" (60.5%) "Dry mouth or nose" (36.8%) "Mask leaks and sore eyes" (31.6%)	"Discomfort" (46%) "Tooth pain" (27%) "Loosening/movement of teeth" (27%) "Bite changes" (27%)
Barriers to accessing treatment		
No barriers	24 (63%)	6 (55%)
Cost	9 (24%)	4 (36%)
Availability of treatment in South West	2 (5%)	2 (18%)
Common barriers to using device	"Noise and frequent awakening" (32.4%) "Inconvenient" (32.4%) "Side effects" (18.9%)	"I didn't feel it was helping me at all" (27%) "Side effects" (27%)

CPAP continuous positive airway pressure.

being referred, 57% had acted on their referral one year later, which is higher than the 49% in our study who consulted a GP.

Of those that consulted their GP, only 40% had a confirmatory sleep study and the rate was even lower for those that saw a pharmacist (25%). Reasons for this were that participants and their GPs thought the screening test was adequate to diagnose OSA. While the information letter implied that further assessment was recommended to confirm the results of the screening test, portable monitors have actually been shown to have a high specificity and hence a confirmatory test may not be warranted in people with a high pre-test probability.[9–11]

Rural patients are generally disadvantaged in their access to health services but this was not reflected in our study, with the majority of participants reporting no barriers to accessing their confirmatory sleep study. Whilst Shaw et al.[17] found that the main barriers to undergoing a sleep study in a group of African Americans was environmental factors, such as sleeping in a strange environment, our study did not identify these as significant barriers.

Table 3
Comparison of efficacy of treatment options: how participants rated their sleep, daytime sleepiness, snoring, mood and the number of times they need to pass water at night now compared to when they underwent the screening

	Treatment that included CPAP (n = 38)	Treatment that did not include CPAP (n = 15)	No treatment (n = 102)^
Sleep			
Sleep better now	24 (63.2%)	7 (46.7%)	24 (23.5%)
No change	13 (34.2%)	7 (46.7%)	67 (65.6%)
Sleep worse now	1 (2.6%)	1 (6.7%)	11 (10.8%)
Daytime sleepiness			
Less sleepiness now	19 (50%)	6 (40.0%)	16 (15.7%)
No change	17 (44.7%)	8 (53.3%)	66 (64.7%)
More sleepiness now	2 (5.3%)	1 (6.7%)	20 (19.6%)
Snoring			
Snore less now	27 (71.1%)	8 (53.3%)	23 (22.3%)
No change	3 (7.9%)	4 (26.7%)	54 (52.4%)
Snore more now	2 (5.3%)	1 (6.7%)	8 (7.8%)
Can't comment	6 (15.8%)	2 (13.3%)	18 (17.5%)
Mood			
Mood better now	15 (39.5%)	5 (33.3%)	10 (9.6%)
No change	23 (60.5%)	9 (60.0%)	90 (86.5%)
Mood worse now	-	1 (6.7%)	4 (3.9%)
Passing water at night			
Less often now	6 (15.8%)	-	14 (13.5%)
No change	26 (68.4%)	13 (86.7%)	74 (71.2%)
More often now	6 (15.8%)	2 (13.3%)	16 (15.4%)
ESS Score, mean ± SD			
All participants	6.16 ± 4.89	5.07 ± 3.55	5.98 ± 4.09
2010-15 cohort only	6.11 ± 4.98 (n = 28)	5.18 ± 3.74 (n = 11)	5.83 ± 3.77 (n = 69)
Original score for 2010-15 cohort*	8.71 ± 4.31 (n = 28)	5.91 ± 3.24 (n = 11)	6.39 ± 3.63 (n = 69)

CPAP = continuous positive airway pressure, ESS = Epworth Sleepiness Scale, a quantitative indication of the level of daytime sleepiness (minimum score zero, maximum score 24).
* Original ESS score only available for 2010-15 cohort.
^ Number derived from those that recalled receiving results but did not have treatment (n = 106) minus 4 participants that did not answer these questions.

The rate of treatment uptake in this study (27.6% of responders) is much higher than the rates reported by Gottlieb et al.[16] In their study, people were screened using portable monitors and informed of their result but were not referred for any further testing.[16] A 5-year follow-up questionnaire found that, of those that had an AHI ≥15 on the screening test, only 18.6% reported a physician diagnosis of OSA and just 8.4% reported receiving treatment. However, it should be noted that the authors of this paper did not clarify whether these rates related to treatment uptake or treatment adherence after five years.

CPAP is the gold standard treatment for OSA and was the most common treatment option in our study. In contrast, an earlier Australian population study[39] found surgery (54%) was the most prescribed treatment option to treat OSA and snoring. In our study, CPAP was more effective than other forms of treatment in regard to improving sleep, daytime sleepiness, snoring, mood and nocturia and CPAP use resulted in the largest decrease in ESS score from baseline (30%). This is lower than reported in other studies which range from 44% to 47.8%.[25,26]

We found that self-reported adherence rates were higher with CPAP (84%) compared to oral appliances (64%). The rates are comparable to those found in previous studies which used objective measures of compliance.[24–27] Previous studies have identified effective troubleshooting of treatment problems and side effects, education and support, and cost factors to be predictors of uptake and compliance of CPAP.[28] However, in our study, only 5% were unable to get troubleshooting help and only 24% reported cost as a barrier whilst 92% reported side effects. Despite being in a rural setting, the majority reported no barriers to accessing treatment. Whilst the common barriers to using CPAP were related to the device itself, the most common barrier to using an oral appliance was a lack of symptom improvement.

The logistic regression analyses identified subjective measures of either snoring, breathing pauses or daytime tiredness as predictors of whether people displayed healthcare-seeking behavior. Of these, daytime tiredness is the only measure to affect the individual's functioning and was only found to be a predictor of treatment uptake. This finding is not surprising considering that treatment improves tiredness and is consistent with Skinner's[18] findings for uptake of CPAP. An assessment of snoring or breathing pauses requires another person's input so it is likely that interfering with another person's sleep was a motivating factor and in many cases, the other person could have encouraged the person to seek help, which is supported by 28.9% of people selecting "someone (for example, spouse or friend) said I should" in response to the question about motivations for seeking help. AHI was a primary predictor of taking any action and of treatment uptake. This is also consistent with the findings of Skinner 2013,[18] who found that AHI was predictive of the decision to undergo a CPAP trial.

This study used two different screening methods (nasal airflow in the 2005-2007 cohort and nasal airflow with oximetry in the 2010-2015 cohort). Interestingly, cohort was not a predictor of any of the four key outcomes, suggesting that more advanced screening tools do not result in higher levels of healthcare-seeking or lifestyle modification behaviour.

Another surprising finding was that 'fallen asleep driving' was not a predictor of action. In those who admitted to falling asleep driving, the treatment uptake rate was similar to that amongst those who did not (38.1% and 32.8%, respectively, Table 4). Furthermore, their CPAP compliance rates were lower than for the overall group (71.4% compared with 84%).

Although participants of the original surveys were unaware they would be followed up and hence their actions could not be influenced by being part of this study (the Hawthorne effect), a limitation is that the average time since completing the original survey was over five years. Another limitation was that compliance was measured subjectively. Previous studies have measured compliance objectively by using the CPAP machine data.[24,26]

One major limitation of this study was the method of screening. Whilst portable monitors are capable of providing an equivalent diagnosis to in-laboratory polysomnography in patients with a high pre-test probability of moderate to severe OSA, they do not accurately measure sleep time, under-estimate the AHI and are not yet appropriate for general screening of asymptomatic populations.[10]

Given that ApneaLink will tend to underestimate the severity of OSA relative to polysomnography, we are likely to have included a higher proportion of participants with more severe OSA than if we had selected participants based on polysomnography. The relevance of our findings to those with mild OSA remains to be determined, however, waking unrefreshed and loudness of snoring, independently of AHI, were predictors of seeking further management.

Some subjects were asked to remember events from up to 11 years ago. Recall bias was not controlled for in the data analysis. Another limitation was that the accuracy of responses was not verified. One method for increasing the accuracy of responses would be to exclude those with diagnosed dementia or cognitive impairment.

Unfortunately, information about some potential predictors of action, such as race/ethnicity and socioeconomic status, was not collected in the current survey. Whilst the current survey collected data on whether patients were seen by a primary care provider, it would also be relevant to collect information on whether participants saw a sleep physician as this may have impacted the likelihood of undergoing diagnostic testing.

With an ageing population and the rates of other risk factors for OSA such as obesity on the rise, strategies to diagnose and treat OSA are needed to reduce the burden of OSA in the community. For a screening program to be effective, people must undergo appropriate follow-up diagnostic testing and treatment. A number of population wide screening programs are already in existence in Australia, for example the fecal occult blood test (FOBT) for bowel cancer. The pilot study for the FOBT found that 62.1% of those who screened positive visited their GP.[40] However, the participation rate was only 45.4%, and presumably only those who intended to take action would have taken part. In contrast, screening in the current study was a mandatory component and hence lower rates of healthcare-seeking behaviour would be expected. Overall, our rates of follow-up with the GP and confirmatory testing are comparable with other existing screening programs. This, in conjunction with the high rates of healthcare-seeking or lifestyle modification behaviour, treatment uptake and compliance with treatment, provides promising evidence that in-home community screening for OSA could contribute towards relieving the morbidity associated with OSA, especially if further health promotion interventions are implemented.

Disclosure

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Table 4
Potential predictors of action for four key outcomes

		Any action taken (n = 103, 64.8%)		Discuss with GP (n = 78, 49.1%)		Confirmatory sleep study (n = 33, 20.8%)		Treatment uptake (n = 53, 33.3%)	
			P		*P*		*P*		*P*
Method of notification of results^	Letter in mail (a)	71.6% (n = 53)	0.025*	52.7% (n = 39)	0.067	17.6% (n = 13)	0.518	31.1% (n = 23)	0.696
	Discussion with researcher (b)	72.7% (n = 24)	Excluding (c): *P* = .906	60.6% (n = 20)	Excluding (c): *P* = .167	27.3% (n = 9)	Excluding (c): *P* = .251	39.4% (n = 13)	Excluding (c): *P* = .401
	Cannot recall (c)	50% (n = 26)		36.5% (n = 19)		21.2% (n = 11)		32.7% (n = 17)	
Age	< 65 years	66.2% (n = 45)	0.750	50% (n = 34)	0.837	20.6% (n = 14)	0.964	39.7% (n = 27)	0.141
	≥ 65 years	63.7% (n = 58)		48.4% (n = 44)		20.9% (n = 19)		28.6% (n = 26)	
Time since original survey	< 6 years	69.1% (n = 76)	0.088	50.9% (n = 56)	0.484	20% (n = 22)	0.725	35.5% (n = 39)	0.395
	≥ 6 years	55.1% (n = 27)		44.9% (n = 22)		22.4% (n = 11)		28.6% (n = 14)	
Gender	Male	62.6% (n = 67)	0.413	48.6% (n = 52)	0.868	20.6% (n = 22)	0.931	32.7% (n = 35)	0.811
	Female	69.2% (n = 36)		50% (n = 26)		21.2% (n = 11)		34.6% (n = 18)	
Marital status	Single	33.3% (n = 1)	0.335	0%	0.182	0%	0.668	0%	0.464
	Married or de facto	63.9% (n = 85)		48.9% (n = 65)		21.1% (n = 28)		33.8% (n = 45)	
	Divorced, widowed or separated	73.9% (n = 17)		56.5% (n = 13)		21.7% (n = 5)		34.8% (n = 8)	
Bed partner^	Yes	62.5% (n = 70)	0.353	45.5% (n = 51)	0.170	21.4% (n = 24)	0.746	31.3% (n = 35)	0.390
	No	70.2% (n = 33)		57.4% (n = 27)		19.1% (n = 9)		38.3% (n = 18)	
AHI category	Mild (score 16-20) (a)	54.7% (n = 35)	0.029* Combining (b) and (c) into one category: *P* = .029*	39.1% (n = 25)	0.096	12.5% (n = 8)	0.084 Combining (b) and (c) into one category:	15.6% (n = 10)	<0.001* Combining (b) and (c) into one category: *P* = <.001*
	Moderate (score 21-30) (b)	63.6% (n = 28)		52.3% (n = 23)	Combining (b) and (c) into one category: *P* = .039*	29.5% (n = 13)		40.9% (n = 18)	
	Significant/severe (score >30) (c)	78.4% (n = 40)		58.8% (n = 30)		23.5% (n = 12)	*P* = .035*	49% (n = 25)	
Cohort	2005-07	55.1% (n = 27)	0.088	44.9% (n = 22)	0.484	22.4% (n = 11)	0.725	51.9% (n = 14)	0.962
	2010-15	69.1% (n = 76)		50.9% (n = 56)		20% (n = 22)		51.3% (n = 39)	
Employment^	In paid employment or self-employed	70.1% (n = 47)	0.290	50.7% (n = 34)	0.877	23.9% (n = 16)	0.410	40.3% (n = 27)	0.240
	Retired	62.1% (n = 54)		48.3% (n = 42)		19.5% (n = 17)		27.6% (n = 24)	
	Other	40% (n = 2)		40% (n = 2)		0%		40% (n = 2)	
Private health insurance^	Yes	66.2% (n = 90)	0.370	49.3% (n = 67)	0.898	20.6% (n = 28)	0.900	34.6% (n = 47)	0.425
	No/unsure	56.5% (n = 13)		47.8% (n = 11)		21.7% (n = 5)		26.1% (n = 6)	
BMI (kg/m^2)	< 30 (not obese)	56.3% (n = 49)	0.014*	42.5% (n = 37)	0.070	18.4% (n = 16)	0.419	24.1% (n = 21)	0.007*
	≥ 30 (obese)	75% (n = 54)		56.9% (n = 41)		23.6% (n = 17)		44.4% (n = 32)	
Waist circumference (cm)	< 102 for males < 88 for females	51.5% (n = 34)	0.003*	36.4% (n = 24)	0.007*	15.2% (n = 10)	0.142	21.2% (n = 14)	0.006*
	≥ 102 for males ≥ 88 for females	74.2% (n = 69)		58.1% (n = 54)		24.7% (n = 23)		41.9% (n = 39)	
Systolic blood pressure (mmHg)	< 140	68.8% (n = 66)	0.196	49% (n = 47)	0.976	19.8% (n = 19)	0.712	31.3% (n = 30)	0.492
	≥ 140	58.7% (n = 37)		49.2% (n = 31)		22.2% (n = 14)		36.5% (n = 23)	

Cholesterol (mmol/L)	< 5.5	60.6% (n = 40)	0.407	43.9% (n = 29)	0.220	21.2% (n = 14)	0.960	40.9% (n = 27)	0.077
	≥ 5.5	67% (n = 61)		53.8% (n = 49)		20.9% (n = 19)		27.5% (n = 25)	
HDL (mmol/L)	< 1 for males < 1.3 for females	60.6% (n = 40)	0.131	60.9% (n = 14)	0.245	8.7% (n = 2)	0.116	52.2% (n = 12)	0.036*
	≥ 1 for males ≥ 1.3 for females	61.9% (n = 83)		47.8% (n = 64)		23.1% (n = 31)		29.9% (n = 40)	
Triglycerides (mmol/L)	< 2	66.1% (n = 84)	0.330	50.4% (n = 64)	0.713	22.8% (n = 29)	0.251	34.6% (n = 44)	0.404
	≥ 2	56.7% (n = 17)		46.7% (n = 14)		13.3% (n = 4)		26.7% (n = 8)	
Snoring	Yes	65.5% (n = 93)	0.586	49.3% (n = 70)	0.862	22.5% (=32)	0.110	36.6% (n = 52)	0.011*
	No or don't know	58.8% (n = 10)		47.1% (n = 8)		5.9% (n = 1)		5.9% (n = 1)	
Snoring loudness	As loud as talking or softer (a)	59.0% (n = 49)	0.124	42.2% (n = 35)	0.189	13.3% (n = 11)	0.019*	26.5% (n = 22)	0.106
	Louder than talking (b)	76.6% (n = 36)	Excluding (c): $P =$	57.4% (n = 27)	(a) and (b) only: $P =$	34.0% (n = 16)	Excluding (c): $P =$	44.7% (n = 21)	Excluding (c): $P =$
	Don't know (c)	62.1% (n = 18)	.043*	55.2% (n = 16)	.094	20.7% (n = 6)	.005*	34.5% (n = 10)	.034*
Snoring bother others	Yes	73.5% (n = 72)	0.014*	55.1% (n = 54)	0.090	26.5% (n = 26)	0.026*	44.9% (n = 44)	<0.001*
	No	53.7% (n = 29)		40.7% (n = 22)		11.1% (n = 6)		14.8% (n = 8)	
Fallen asleep driving	Yes	61.9% (n = 13)	0.734	47.6% (n = 10)	0.863	28.6% (n = 6)	0.352	38.1% (n = 8)	0.635
	No	65.7% (n = 90)		49.6% (n = 68)		19.7% (n = 27)		32.8% (n = 45)	
Snore frequency	Never or almost never (a)	50.0% (n = 3)	0.006*	50.0% (n = 3)	0.121	33.3% (n = 2)	0.105	33.3% (n = 2)	0.108
	1-2 times per week or less (b)	40.0% (n = 12)	Excluding (d): $P =$	30.0% (n = 9)	Excluding (d): $P =$	16.7% (n = 5)	Excluding (d): $P =$	20.0% (n = 6)	Excluding (d): $P =$
	At least 3-4 times per week (c)	72.0% (n = 72)	.005*	55.0% (n = 55)	.056	26.0% (n = 26)	.503	41.0% (n = 41)	.109
	Don't know (d)	80.0% (n = 12)		46.7% (n = 7)		0%		20% (n = 3)	
Breathing pauses	Never or almost never (a)	53.1% (n = 26)	0.074	36.7% (n = 18)	0.031*	14.3% (n = 7)	0.053	20.4% (n = 10)	0.017*
	1-2 times per week or less (b)	72.4% (n = 21)	Excluding (d): $P =$	62.1% (n = 18)	Excluding (d): $P =$	27.6% (n = 8)	Excluding (d): $P =$	48.3% (n = 14)	Excluding (d): $P =$
	At least 3-4 times per week (c)	79.4% (n = 27)	.031*	64.7% (n = 22)	.019*	35.3% (n = 12)	.078	47.1% (n = 16)	.012*
	Don't know (d)	63.6% (n = 28)		43.2% (n = 19)		13.6% (n = 6)		27.3% (n = 12)	
Tired after sleeping	Never or almost never	59.3% (n = 32)	0.495	44.4% (n = 24)	0.640	16.7% (n = 9)	0.147	22.2% (n = 12)	0.046*
	1-2 times per week or less	66.1% (n = 41)		53.2% (n = 33)		17.7% (n = 11)		33.9% (n = 21)	
	At least 3-4 times per week	70.7% (n = 29)		48.8% (n = 20)		31.7% (n = 13)		46.3% (n = 19)	
Tired during wake hours	Never or almost never	62.8% (n = 27)	0.817	46.5% (n = 20)	0.818	20.9% (n = 9)	0.045*	27.9% (n = 12)	0.031*
	1-2 times per week or less	64.4% (n = 47)		52.1% (n = 38)		13.7% (n = 10)		27.4% (n = 20)	
	At least 3-4 times per week	69.0% (n = 29)		47.6% (n = 20)		33.3% (n = 14)		50.0% (n = 21)	
Smoker at time of original survey	Yes	80% (n = 4)	0.416	60% (n = 3)	0.548	40% (n = 2)	0.356	40% (n = 2)	0.689
	No	62% (n = 67)		46.3% (n = 50)		22.2% (n = 24)		31.5% (n = 34)	
FVC (% predicted)	< 100	67.1% (n = 57)	0.669	50.6% (n = 43)	0.733	22.4% (n = 19)	0.593	31.8% (n = 27)	0.560
	≥ 100	63.8% (n = 44)		47.8% (n = 33)		18.8% (n = 13)		36.2% (n = 25)	
FEV_1 (% predicted)	< 100	67.4% (n = 62)	0.565	47.8% (n = 44)	0.645	23.9% (n = 22)	0.243	33.7% (n = 31)	0.982
	≥ 100	62.9% (n = 39)		51.6% (n = 32)		16.1% (n = 10)		33.9% (n = 21)	
ESS score°	< 10 (normal)	63.5% (n = 54)	0.020*	68.0% (n = 39)	0.052	27.8% (n = 15)	0.725	31.8% (n = 27)	0.136
	≥ 10 (abnormal)	88.0% (n = 22)		45.9% (n = 17)		31.8% (n = 7)		48% (n = 12)	

GP = general practitioner AHI = apnoea hypopnoea index. BMI = body mass index. HDL = high density lipoprotein. FVC = forced vital capacity. FEV_1 = forced expiratory volume during first second. ESS = Epworth Sleepiness Scale.

^ indicates data collected at current survey, all other data collected at original 2005-2007 and 2010-2015 surveys.

* $P < .05$.

° Data only available from 2010-2015 cohort (therefore excluded from logistic regression).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleh.2018.10.009.

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