

Technical Report

“Effects of Nocturnal Exposure to the Biow System”

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Introduction

Sleep is a natural, periodic, transient, reversible, and essential behaviour for life, as its absolute deprivation, at least in mammals, leads to death. The regulation of sleep involves hypothalamic homeostatic and circadian mechanisms, but individual age and some personal factors also play a role. During sleep, the respiratory system becomes vulnerable, making it easier for sleep-related breathing disorders to occur, with a reduction in ventilatory response (more than 50% compared to wakefulness) due to decreased sensitivity of the centers to both chemical and mechanical stimuli, along with a significant increase in upper airway resistance, overall reduction in muscle tone leading to decreased functional residual respiratory capacity, decreased activity of chest muscles, all contributing to hypoventilation. In essence, reduced ventilation and increased vulnerability in the REM phase promote the occurrence of prolonged apneas, significant decreases in ventilation, and intense desaturations of oxyhemoglobin.

Methodology

Sleep disturbances affect an increasingly large proportion of the population and are associated with numerous conditions (stressful events, medication side effects, medical illnesses, etc.). A recent proof-of-concept study on the effect of the Biow system on sleep shows significant improvements in sleep efficiency and quality. This study was conducted in collaboration with the Sleep Unit (<https://www.cun.es/nuestros-profesionales/servicios-medicos/unidad-sueno>) and the Preventive Medicine Chair (Dr. F Guillén) at the University Clinic of Navarra.

With the corresponding authorization from the Research Ethics Committee of the University of Navarra (attached), the study titled "Impact of the Biow System on Sleep Quality," led by Dr. E. Urrestarazu, analyzed the effect of the Biow system on volunteers with moderate sleep disturbances using a combined methodology of actigraphy and sleep diary recording based on validated questionnaires (Pittsburgh, Epworth, ISI, Beck Anxiety and Depression) in clinical practice for diagnosis, allowing for a quantitative estimation of sleep. Additionally, actigraphy provides an indirect idea of sleep structure through the patient's physical activity and movements, performed using a wristwatch-shaped device placed on the arms or legs, equipped with an accelerometer indicating limb movement throughout the day and night.

The pilot study included a sample of 31 patients (17 women and 14 men) who reported poor sleep quality. Subjects with moderate or severe apnea detected by respiratory polygraphy were excluded; 7 volunteers with positional sleep apnea syndrome (one moderate, one severe, and the rest mild). The global AHI of the remaining participating volunteers was always below 15 (inclusion and exclusion criteria). According to the severity scale of ISI insomnia, volunteers exhibited subclinical or mild insomnia (16 subjects) or moderate (15 subjects) based on specific clinical scales (Pittsburgh, Epworth Sleepiness Scale, Spontaneous Arousals, Awakening index, sleep latency).

CASO	Actividad Respiratoria Basal (criterios inclusión y exclusión)				
	IAH	IDO	RONQUIDO %	SAT MEDIA	SAT MIN
1	7,6	7,3	4,4	97,8	91
2	4,8	6,3	1,8	95,3	87
3	3	1,3	1	92,3	83
4	12,4	12,6	18,7	98,3	87
5	1,3	1,6	0,2	96	93
6	1,4	0	0,3	97,7	96
7	5,5	6	5,6	95,9	88
8	4,3	9,9	0,2	98,7	91
9	>15	nd	nd	nd	nd
10	7,1	7,3	9,3	95,3	90
11	>15	nd	nd	nd	nd
12	13,5	13,6	8,4	96,7	89
13	3,1	4,7	1,3	96,6	84
14	2,9	4	30,3	97,4	94
15	3,5	3,7	1,1	98,3	91
16	1,5	1,7	0,2	97,3	93
17	0,3	0,3	0	98,1	95
18	6,4	7,9	9,1	95,9	86
19	>15	nd	nd	nd	nd
20	9,7	12,9	3	93,3	83
21	3,8	4	0,4	94,1	90
22	>15	nd	nd	nd	nd
23	>15	nd	nd	nd	nd
24	>15	nd	nd	nd	nd
25	3,1	5,4	8,8	94,4	90
26	>15	nd	nd	nd	nd
27	6	6,8	17,4	93,6	88
28	1,2	1,1	14,2	92,6	89
29	1,8	1,7	14,8	94,9	90
30	0,7	1,1	3,4	95	93
31	0,1	2,3	0,1	95,2	81

Results

The sleep parameters recorded over 2 weeks under baseline conditions were compared with those recorded over 2 weeks after exposure to the Biow system installed in the participants' bedrooms. The variables under study were bedtime hours, sleep hours, sleep onset latency (daytime only), number of awakenings, wakefulness during sleep, and sleep efficiency. Sleep efficiency is the percentage of time spent in bed during which the person is asleep. Sleep efficiency is calculated as the sum of stage N1, stage N2, stage N3, and REM sleep, divided by the total time in bed and multiplied by 100, providing a general idea of the patient's sleep quality. The perceived sleep quality by the patient in both periods was also compared, measured using the Pittsburgh Sleep Quality Index. The following tables display the values obtained for the variables studied.

CUESTIONARIO ISI								
CASO	1a	1b	1c	2	3	4	5	Total
1	2	3	3	3	4	1	3	19
2	0	1	0	2	2	0	1	6
3	2	2	1	3	2	2	3	15
4	3	2	2	2	2	1	3	15
5	3	2	0	1	2	1	3	12
6	0	4	4	3	2	3	3	20
7	1	1	0	4	2	1	3	12
8	1	3	3	4	3	3	3	20
10	3	3	3	4	2	2	2	19
11	2	1	1	1	1	0	1	7
12	1	1	3	3	0	0	2	10
13	2	1	1	3	3	1	1	12
14	2	2	3	3	1	0	1	12
15	1	2	1	3	3	1	2	13
16	1	0	2	1	2	0	0	6
17	1	0	0	3	2	0	1	7
18	2	3	3	4	3	2	2	19
19	2	4	3	3	3	2	3	20
20	0	2	3	3	2	1	2	13
21	0	1	1	1	3	2	2	10
22	nd	nd	nd	nd	nd	nd	nd	nd
23	nd	nd	nd	nd	nd	nd	nd	nd
24	nd	nd	nd	nd	nd	nd	nd	nd
25	0	1	1	4	3	3	3	16
26	1	1	2	2	2	1	1	10
27	1	2	3	4	2	2	3	17
28	1	3	4	4	1	0	3	16
29	0	1	1	2	2	0	1	7
30	2	1	3	3	4	1	2	16
31	2	0	3	2	2	0	1	10

La puntuación total se valora como sigue:

0-7 = ausencia de insomnio clínico

8-14 = insomnio subclínico

15-21 = insomnio clínico (moderado)

22-28 = insomnio clínico (grave)

Cuestionario EPWORTH (normal si <10)									
Caso	A	B	C	D	E	F	G	H	Total
1	0	0	0	0	1	0	0	0	1
2	1	0	0	2	1	0	0	0	4
3	1	1	0	1	0	0	0	0	3
4	1	1	0	1	0	0	0	0	3
5	0	1	0	0	0	0	0	0	1
6	2	2	0	1	1	0	1	0	7
7	0	2	0	1	2	0	0	0	5
8	0	2	1	2	3	1	1	0	10
9	nd	nd	nd	nd	nd	nd	nd	nd	nd
10	0	0	0	0	0	0	0	0	0
11	0	0	0	1	1	0	1	0	3
12	1	0	0	1	1	0	1	0	4
13	2	1	0	0	3	0	1	0	7
14	0	1	0	0	0	0	0	0	1
15	2	2	2	2	3	1	2	1	15
16	nd	nd	nd	nd	nd	nd	nd	nd	nd
17	0	1	0	0	1	0	1	0	3
18	2	2	0	1	1	1	2	0	9
19	1	1	0	0	1	0	0	0	3
20	1	1	1	1	2	0	1	0	7
21	0	1	0	1	1	0	0	0	3
22	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	nd	nd	nd	nd	nd	nd	nd	nd	nd
25	3	2	1	2	3	0	3	0	14
26	1	1	0	1	1	0	0	0	4
27	2	1	1	3	2	0	1	0	10
28	0	2	0	1	2	0	0	0	5
29	1	3	0	0	3	0	1	0	8
30	1	1	0	2	1	0	0	0	5
31	0	0	0	0	0	0	0	0	0

A Sentado leyendo

B Sentado frenteTV

C Sentado en lugar público

D En coche no conduciendo

E Recostado después de comer

F Hablando con alguien

G Sentado después de comer

H Conduciendo, si para el tráfico unos minutos

Cuestionario Pittsburgh Basal										
CASO	1C	Previo 2C	2C	3C	4C	Previo 5C	5C	6C	Previo 7C	7C GLOBAL
1	2	3	2	2	1	7	1	3	3	2 13
2	1	2	1	1	0	12	2	0	3	2 7
3	2	2	1	0	0	7	1	3	1	1 8
4	2	1	1	1	0	3	1	3	2	1 9
5	2	3	2	0	2	3	1	1	0	0 8
6	2	1	1	3	1	3	1	0	3	2 10
7	2	2	1	1	2	3	1	0	2	1 8
8	1	1	1	1	1	1	1	0	2	1 6
9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10	1	3	2	1	0	1	1	3	1	1 9
11	2	4	1	1	3	3	1	0	1	1 9
12	2	3	2	1	3	0	0	3	1	1 12
13	2	1	1	0	1	2	1	0	1	1 6
14	2	2	1	2	1	0	0	3	0	0 9
15	2	3	2	1	1	2	1	3	2	1 11
16	2	4	2	1	2	1	1	0	2	1 9
17	2	4	1	1	2	0	0	0	0	0 6
18	1	2	1	2,00	2	3	1	3	2	1 11
19	2	6	3	3,00	3	3	1	3	2	1 16
20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
21	2	2	1	0,00	1	3	1	3	2	1 9
22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
25	2	1	1	0,00	1	3	1	0	5	3 8
26	2	2	1	1,00	2	3	1	0	0	0 7
27	2	1	1	1,00	1	3	1	1	0	0 7
28	2	0	0	1	0	3	1	3	0	0 7
29	1	2	1	1,00	1	3	1	0	1	1 6
30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
31	1	3	2	0,00	2	2	1	1	0	0 7

1C 1Componente Calidad subjetiva del sueño

Previo 2C 2Previo 5A+Sleep latency

2C 2Componente (suma 2+5: 0 si suman 0; 1 si suman 1-2; 2 si suman 3+4; 3 si suman 5-6): Latencia de sueño

3C 3Componente: duración de sueño

4C 4Componente: eficiencia habitual de sueño

Previo 5C 5suma5B-5J

5C 5Componente: alteraciones del sueño (si la suma es 0 se pone 0; si suma 1-9 se pone 1; si suma 10-18 es 2; si suma 19-27 es 3)

6C 6Componente (uso de medicación para dormir)

Previo 7C 7Previo 8+9

7C 7Componente (disfunción durante el día) Su suma 0 es 0; si suma 1-2 es 1; si suma 3-4 es 2; si suma 5-6 es 3)

Bueno si 0 - 5

Mala si es >5

El peor es 21

Cuestionario Pittsburgh Biow										
CASO	1C	Previo 2C	2C	3C	4C	Previo 5C	5C	6C	Previo 7	7C GLOBAL
1	2	5	3	2	1	6	1	3	3	2 14
2	1	1	1	1	0	12	2	0	3	2 7
3	1	2	1	0	0	5	1	3	1	1 7
4	2	1	1	1	0	3	1	3	0	0 8
5	0	2	1	0	2	3	1	0	0	0 4
6	2	1	1	3	1	3	1	0	3	2 10
7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
8	0	1	1	0	1	2	1	0	0	0 3
9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10	1	2	1	1	0	2	1	3	2	1 8
11	2	4	2	3	3	2	1	0	1	1 12
12	2	2	1	3	2	3	1	3	0	0 12
13	1	1	1	0	1	3	1	0	2	1 5
14	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	1	2	1	1	1	2	1	3	1	1 9
16	1	2	1	0	1	1	1	0	1	1 5
17	1	1	1	0	1	0	0	0	1	1 4
18	1	1	1	1	1	3	1	3	2	1 9
19	1	3	2	1	2	3	1	3	0	0 10
20	1	0	0	2	0	2	1	0	0	0 4
21	1	2	1	0	1	1	1	0	1	1 5
22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
25	2	1	1	0	1	3	1	0	4	2 7
26	0	2	1	1	2	3	1	0	0	0 5
27	1	2	1	1	2	1	1	0	0	1 7
28	2	1	1	1	1	3	1	3	0	0 9
29	1	4	2	1	3	2	1	1	1	1 10
30	2	4	2	1,00	2	3	1	0	2	1 9
31	1	3	2	0	2	2	1	1	1	1 8

CASO	Cuestionario Ansiedad Beck																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1	2	1	3	3	1	2	0	1	2	2	0	1	2	0	0	1	0	0	0	1
2	2	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	2
3	1	1	0	1	0	1	0	0	0	2	1	0	1	0	1	0	0	0	0	0	0
4	1	1	0	1	1	1	1	0	0	2	0	0	1	1	0	0	0	0	0	2	1
5	0	0	1	3	3	1	1	2	3	3	2	1	3	3	3	0	1	3	0	0	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
13	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
14	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	0	0	1	2	0	2	1	2	0	2	1	0	1	1	1	0	0	1	1	0	0
16	1	1	1	2	1	1	2	1	1	2	2	1	2	2	2	0	1	2	0	1	1
17	1	0	1	2	1	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1
18	1	0	1	2	0	1	2	0	0	2	1	1	1	0	1	0	0	1	0	0	0
19	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
25	1	2	0	1	1	2	0	1	0	1	0	0	1	0	0	0	1	2	0	1	2
26	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0
27	0	0	1	0	1	0	0	0	0	1	0	0	1	1	1	0	0	1	0	0	0
28	0	0	0	1	1	0	0	1	1	2	0	0	1	0	0	1	1	0	0	0	1
29	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
30	1	0	1	2	3	1	2	1	2	3	3	2	1	3	0	0	2	0	0	0	0
31	0	0	0	0	2	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0

CASO	Cuestionario Depresión Beck																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	1	2	0	1	0	0	3	0	0	0	0	3	2	1	1A	0	1A	2	1	0
2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2a	0	0	2	3	0
3	0	1	0	1	0	0	0	1	0	0	1	1	1	0	1	1b	1	0	1	1	0
4	0	0	0	1	2	3	1	1	0	1	1	0	1	0	1	1b	1	2a	1	0	0
5	0	0	0	1	0	0	3	0	0	0	0	1	1	2	1	1b	0	1b	1	1	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2A	0	0	1	1	0
7	0	1	0	1	1	0	0	0	0	0	1	1	0	0	1	2B	1	1B	0	1	0
8	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	3b	0	0	1	1	0
9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1b	0	0	1	1	2
11	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1a	0	0	0	0	0
15	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1B	1	0	1	1	0
16	0	0	0	0	1	0	1	1	0	0	1	0	1	1	1	1a	0	1b	1	1	0
17	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1a	0	1a	0	1	0
18	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	1a	0	1b	1	1	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1a	0	1b	0	0	0
21	1	1	0	1	0	0	2	1	0	1	1	1	0	0	1	0	1	0	1	1	0
22	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	3a	1	0	0	2	1
25	1	1	1	1	1	1	1	2	0	0	0	1	1	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1b	0	0	1	1	0
27	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1b	0	0	0	0	0
28	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	3b	1	0	1	0	1
29	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1b	0	0	0	0	0
30	1	1	0	0	0	0	0	1	0	0	1	2	2	1b	1	1a	1	1a	2	2	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The use of the Biow system for 2 consecutive weeks resulted in a statistically significant improvement in sleep quality perceived by individuals with sleep problems. Both the variables recorded in sleep diaries and the Pittsburgh Sleep Quality Index score improved. Among the statistically significant results derived from the use of the Biow system for 15 consecutive days, notable improvements include: i) enhancement in the Pittsburgh Sleep Quality Index scale, ii) reduction in sleep latency, iii) decrease in the number of awakenings, and iv) increase in total sleep duration.

Among the calculated variables, before sleeping with exposure to the Biow system, the mean percentage value of sleep efficiency for an average sleep time of 6 hours and 36 minutes was 83.25%, which is below the normal value (85%) as these are patients with sleep disorders. This percentage reached a mean value of 87.51% after 15 days of sleeping under exposure to the

Biow system for the same sleep duration. This statistically significant difference of 4.26 percentage points ($p=/.< 0.004$) implies that the likelihood of the difference being due to chance is 0.4%.

The outcome on sleep quality showed a significant increase ($p=/.<0.001$) at the 15-day mark of sleeping under the effects of the Biow system. Thus, a low percentage of sleep efficiency could result from prolonged sleep latency and prolonged sleep compensation due to lights on with an intermediate amount and quality of sleep. The differences in the most objectively recorded data using actigraphy were not statistically significant.

These pilot study results suggest that the Biow system improves subjective sleep quality even in individuals with mild to moderate insomnia, at least acutely, and reinforce the Biow system as an effective device in treating moderate sleep disturbances and disorders.

Caso	Género	Latencia desde el comienzo (minutos)		Tiempo en cama (horas)		Tiempo de sueño total (horas)		Eficiencia del sueño (%)		N.º Despertares		Calidad	
		BASAL	BIOW	BASAL	BIOW	BASAL	BIOW	BASAL	BIOW	BASAL	BIOW	BASAL	BIOW
1	Mujer	25,41	25	0,29	0,30	0,25	0,23	85,72	76,54	1	1	6,33	5,45
2	Mujer	18,9	14,6	0,35	0,33	0,29	0,30	83,83	89,97	2	1,85	6,7	7,57
3	Varón	17,5	19,61	0,36	0,35	0,35	0,35	83,83	89,97	1,75	1,73	6,42	6,76
4	Varón	23,57	24	0,31	0,31	0,28	0,31	80,04	99,39	3,42	2,85	6,42	6,25
5	Mujer	17,57	17,5	0,37	0,37	0,38	0,33	100,66	87,54	1,78	1	5,78	7,3
6	Varón	18,57	33,57	0,33	0,32	0,18	0,19	54,88	57,27	30	20	nd	nd
7	Mujer	9,71	4	0,31	0,30	0,30	0,29	95,09	96,98	1,42	1,53	nd	nd
8	Mujer	5	5	0,26	0,31	0,22	0,27	72,85	87,74	1,28	1,28	nd	7,5
9	varón	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10	Mujer	66,07	40,71	0,34	0,32	0,24	0,23	69,46	72,92	1,28	1,42	nd	nd
11	Mujer	23,3	26,6	0,31	0,32	0,26	0,28	83,82	86,21	6,58	5,83	5,83	5,91
12	Varón	31,25	17	0,28	0,27	0,17	0,21	60,03	77,98	1,5	1	ND	nd
13	Mujer	8,16	14,58	0,32	0,32	0,27	0,30	85,15	93,67	3,58	3,33	6,42	5,83
14	Varón	42,5	26,4	0,29	0,29	0,25	0,24	84,05	83,57	0	0	ND	nd
15	Mujer	47,5	46,66	0,33	0,36	0,25	0,27	75,11	93,67	1,71	2,08	6,25	6,75
16	Mujer	33	12,85	0,32	0,32	0,30	0,30	92,70	91,72	2,84	1,57	6,7	7,28
17	Varón	26,4	17,8	0,32	0,33	0,29	0,31	91,13	94,64	0,57	1	7	7,5
18	Mujer	14,23	10,7	0,28	0,28	0,22	0,25	80,29	89,74	2	1,78	5,07	6,14
19	Mujer	94	54	0,36	0,33	0,24	0,27	65,23	81,25	3,5	1,83	6,53	7
20	Varón	12	10,41	0,26	0,27	0,25	nd	94,61	92,74	0,54	0,41	7,59	8
21	Varón	21	23	0,37	0,38	0,33	0,34	89,16	88,62	1,21	0,23	6,21	6,84
22	Varón	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
23	Varón	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
24	Varón	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
25	Varón	18,21	17,3	0,34	0,34	0,30	0,31	86,38	91,43	3	3	4,35	3,6
26	Mujer	21	16	0,33	0,34	0,32	0,31	96,86	93,75	4,21	2,35	7,14	7,21
27	Mujer	14,28	13,21	0,35	0,36	0,26	0,29	75,10	81,24	2	1	6,7	7,61
28	Varón	11,7	11	0,29	0,33	0,26	0,26	89,18	77,64	2,57	2,07	6,2	6
29	Mujer	17	12,22	0,34	0,34	0,30	0,31	89,07	92,93	1,56	1,55	6,66	6,75
30	Mujer	48	34,16	0,33	0,36	0,30	0,34	90,71	95,25	2,1	2,66	6,22	6,91
31	Mujer	30	21	0,36	0,37	0,34	0,36	92,94	98,57	1,44	0,55	6,77	6,66

Having determined the effect of the Biow system on moderate sleep disturbances provides crucial information for conducting studies on the prevention and relief of these disturbances. It also supports programs to assist these patients considering their high prevalence, especially as these disorders are often underdiagnosed and inadequately treated. In this regard, based on these preliminary results, a randomized, prospective, double-blind clinical trial is underway for specific sleep disorders (snoring and obstructive sleep apnea), which has been favorably reviewed by the Ethics Committee for Clinical Research of the Quirón Salud-Cataluña Hospital Group. The Covadonga Hospital in Gijón has joined this trial, and the patient recruitment phase remains open.

On the other hand, and considering the technological innovations that enable remote monitoring of clinical parameters using IoT devices, a funding proposal has been submitted to SEKUENS Agency (Asturian Agency for Science, Business Competitiveness, and Innovation) for the promotion of a new clinical trial in Obstructive Sleep Apnea (OSA), (Code Biow/Acu/22/OSA_v1.Version, 4th 2022), utilizing the Biow system's effect monitoring device AcuPebble SA100 for automated sleep apnea diagnosis. The prevalence of OSA exceeds 50% in some countries (3,4), and data suggest that up to one billion adults aged 30 to 60 worldwide suffer from OSA (3). Untreated, OSA significantly increases the risk of cardiovascular and cerebrovascular complications, such as myocardial ischemia, stroke, and arrhythmias (4,5,6). The domiciliary approach for standard OSA diagnosis, using polysomnography or limited cardiopulmonary polygraphy, is the most common in Europe. However, this diagnostic method presents significant limitations related to patient training, invalid signals and tests, device allocation and discomfort, failure rates (5% to 39%) (7), high device costs (8), interpretation complexity, diagnostic delays, and also due to pandemic prevention and control.

To overcome these issues, new "virtual" diagnostic methods are being developed, and in this regard, the use of the AcuPebble SA100 medical device for automated sleep apnea diagnosis has been validated in a large-scale, high-powered clinical trial conducted at the Royal Free Hospital (ClinicalTrials.gov ID: NCT03544086). Published results validate the effectiveness of AcuPebble_SA100 as an automated diagnostic alternative to cardiopulmonary polygraphy (9). Compared to current criteria based on the American Academy of Sleep Medicine's AHI, the device showed 95.33% accuracy (95% CI: 90-62% to 98-10%), 96.84% specificity (95% CI: 91-05% to 99-34%), 92.73% sensitivity (95% CI: 82-41% to 97-98%), 94.4% positive predictive value (95% CI: 84-78% to 98-11%), and 95.83% negative predictive value (95% CI: 89-94% to 98-34%). Over 97% expressed a clear preference for AcuPebble_SA100 over cardiopulmonary polygraphy. All patients used AcuPebble_SA100 correctly, opening doors to more efficient pathways for OSA diagnosis. No adverse effects were recorded, and 100% of recruited patients were able to use the system without training or supervision. AcuPebble technology is also currently being used in several clinical trials in the UK and abroad, with use cases ranging from pediatric sleep apnea diagnosis to COPD research. It is a CE-marked medical device for automated sleep apnea diagnosis. The AcuPebble SA100 system consists of a miniature portable sensor, mobile and web applications, and algorithms stored on a secure cloud platform. AcuPebble SA100 functionality is based on the principle of acoustic detection of physiological body sounds, such as those generated by respiratory and cardiovascular processes. The detected acoustic signal is interconnected with very low-power electronic blocks that optimize both signal quality and wireless transmission to a mobile base station (e.g., a smartphone or tablet). The transmitted signal can then be uploaded to a secure cloud platform and automatically processed by algorithms running on a server.

In this context, we hypothesize that the Biow system, due to its beneficial effect on sleep quality and its response effects on the upper airway, will improve functional conditions at the level of the nasopharynx, velopharynx, oropharynx, and hypopharynx, concerning the integration of multiple factors for upper airway permeability (UAP) and the maintenance of different luminal sections. Regarding the effect of pressures transmitted along the entire respiratory tract, it reduces snoring and episodes of obstructive sleep apnea in patients with this condition. The fundamental objectives expected to be achieved in this project include:

- a) Establishing the severity of snoring from before to after 30, 60, and 70 days of Biow use. Snoring analysis will include: Time asleep with snoring, Percentage of sleep with snoring, Snoring average, Snoring severity (low, medium, and high), and Snoring per hour.

b) Evaluating the effectiveness of Biow use determined by changes in:

- Snoring Intensity compared to baseline values at 30, 60, and 70 days.
- Apnea-Hypopnea Index (AHI) by measuring apnea and/or hypopnea episodes recorded at the beginning and at 30, 60, and 70 days.

Once funding is secured, the study will be submitted to the corresponding Research Ethics Committee for approval.

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Anexos



Universidad
de Navarra

Comité de Ética de la Investigación

D. GABRIEL CANEL CRESPO, Secretario Técnico del Comité de Ética de la Investigación de la Universidad de Navarra,

CERTIFICA: Que, en la sesión ordinaria celebrada el día 11/06/2020, el Comité examinó los aspectos éticos del proyecto **2020.118**, presentado por la Dra. **ELENA URRESTARAZU BOLUMBURU**, como Investigador Principal, titulado:

REPERCUSIÓN DEL SISTEMA BIOW SOBRE LA CALIDAD DE SUEÑO

Memoria de fecha 01/06/2020, hoja de información para el paciente y consentimiento informado de fecha 31/08/2020.

Se revisaron las respuestas de la investigadora a las cuestiones planteadas por el comité en la sesión ordinaria del día 03/09/2020, tras lo que se dictó un informe favorable para la realización de dicho proyecto, dado que ha considerado que se ajusta a las normas éticas esenciales y a los criterios deontológicos que rigen en este centro.

Y para que así conste, expide el presente certificado en Pamplona, a 07 de septiembre de 2020.

D. GABRIEL CANEL CRESPO

Secretario Técnico