THE IMPACT OF ERGONOMIC PILLOWS ON REDUCING SLEEP-RELATED FACIAL WRINKLES

A prospective analysis of sleep wrinkle appearance improvement following the use of a specific anti-wrinkle pillow for 12 weeks.

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ETHICS STATEMENT
All subjects provided written informed consent prior to inclusion.
This article contains photographic images used for scientific and educational purposes within the context of cosmetic dermatology. Written informed consent has been obtained from all individuals whose images are included in this manuscript.

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AUTHOR CONTRIBUTIONS
Sara Gómez-Armayones developed the protocol, coordinated the study as the principal investigator, and analyzed the data. All authors included patients in the study and participated in the production and review of the manuscript.

CONFLICTS OF INTEREST STATEMENT
Authors have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author.

ABSTRACT

Background There is a correlation between night rest and the manifestation of sleep wrinkles, and there is some evidence about the therapeutic and preventive role of non-traditional pillows in redistributing pressure exerted on specific facial regions implicated in the development of these wrinkles.
Objective To demonstrate the reduction of the diameter and roughness of sleep wrinkles through the use of an ergonomic pillow.
Patients/methods. A 12-week observational study was carried out, in which 23 healthy volunteers, women, aged between 37 and 61, were evaluated for a total of 28 sleep lines by visual grading by LiveViz® Micro Quantificare at baseline and following 12 weeks of sleeping on the pillow. The degree of improvement in sleep wrinkles after using the pillow was evaluated by measuring the wrinkles' diameter and roughness parameters using LiveViz® Micro Quantificare. Additionally, the clinical and roughness images generated by the program were assessed by three expert graders.
Results. The use of the pillow resulted in significant decrease of sleep wrinkles after 12 weeks. On the basis of the 3D measurements, a global reduction in wrinkle diameter of 29.4% ($P<0.001$) and a decrease in the roughness parameter Rv by 15.8% ($P<0.009$) were observed. These parameters showed improvement across all age groups, in wrinkles classified in groups II and III of the Glogau scale, and for all wrinkle locations. According to the assessment by three expert graders, 82.1% of the sleep wrinkles exhibited some degree of improvement. No adverse reactions were noted throughout the duration of the study.
Conclusions: Sleeping on a specific ergonomic pillow results in reduction of sleep wrinkles diameter and roughness of the skin.

KEYWORDS
Pillow, sleep wrinkle, roughness, Glogau scale

INTRODUCTION

Sleep wrinkles (SW), also known as sleep lines, were first described as “sleep crases” by Stegman in 1987. As the name suggests, these wrinkles are related to the skin's compression against the pillow, with the lateral sleep posture being most common.[1,2] These lines, not primarily caused by facial muscle movements, differ from wrinkles that map the face's aging and expressions. Clinically, SW typically manifest as oblique to vertical lines across the forehead, in the area around the orbicularis oculi muscle, or on the lateral surfaces of the nose and chin, linking to the superficial musculoaponeurotic system.[3,4] The formation of SW is attributed to the face's distortion under compression, shear, and stress while resting on one's side or stomach,[3] leading to lines that are initially subtle, but may become more pronounced with persistent sleeping in the same posture. As these lines visibly reflect the stress exerted on facial skin, they can be easily replicated by imitating the same pressure with a hand.[5]

Moreover, the formation of these wrinkles may be particularly linked to the natural aging process, which is influenced by a combination of intrinsic (chronologic age, gender, hormonal status) and extrinsic ageing factors (sun exposure, smoking, environmental factors). Stiffening of the stratum corneum and dermis, as well as changes in collagen, elastin fibers, proteoglycans and water content, are consistent features of this process. These changes decrease the elasticity and extensibility of the skin, in addition to diminishing its regenerative capacity and physiological hydration levels.[3]

Sleep position patterns changes with age. The number of position shifts during the night tends to decrease with age, going from an average of 27 to 16 position shifts per night, with an overall average of 20 position shifts per night. Additionally, the lateral sleep position is the most common, averaging 65% of sleep time. It's uncommon to spend the entire sleep time in a single position.[3,5]

The most reliable way to reduce the development of sleep-related wrinkles is to avoid facial distortion during sleep. This can be achieved by sleeping on one's back, as this position typically reduces the amount of facial compression and pressure on the skin. However, sleeping in this position may exacerbate issues related to sleep breathing, such as snoring and sleep apnea. Some individuals may find it uncomfortable or challenging to maintain a supine sleeping position throughout the night, and it may not be a suitable solution for all patients.[3] Another strategy to reduce or prevent the development of SW and ensure a good quality of rest is the use of specially designed pillows aimed at mitigating classic pressure points on the facial region associated with the formation of SW.[3,5,6]

METHODS

Twenty-four women were recruited based on the inclusion and exclusion criteria detailed in **Table 1**. Each participant received detailed information regarding the study's purpose, protocol, timings, benefits, and potential risks. Those willing to participate

signed the informed consent and received an Omnia Sleep&Glow pillow (see **Figure 1**) crafted from polyurethane memory foam (dimensions: 34 x 54 x 13 cm; weight: 1.08 kg) and a pillowcase composed of Tencel (natural eucalyptus fibers) and a bottom layer consisting of 90% polyester and 10% spandex. Instructions were provided for participants to launder the pillowcases according to their regular washing and drying routines.

Figure 1. Features of the Omnia Sleep&Glow pillow.

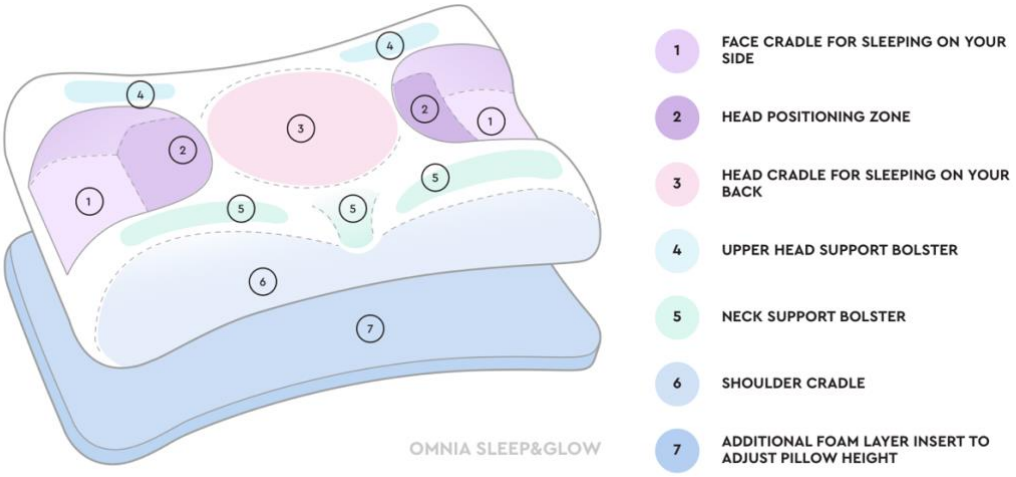


Table 1. Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
• Healthy women between 35 and 65 years of age • Presence of sleep wrinkles diagnosed by an expert dermatologist that do not disappear throughout the day and do not correspond to expression wrinkles • Reproducibility of wrinkles by applying pressure in the area of contact with the pillow • The volunteer signs the informed consent and understands the study	• Pregnancy and breastfeeding • Skin alterations (scars, tattoos, deformities) that may alter the assessment of wrinkles • Cosmetic procedures during the last year and during the study (botulinum toxin, hyaluronic acid and other fillers, ablative and non-ablative lasers) • Skin inflammation that interferes with the assessment of the wrinkles. • Treatment with immunosuppressants during the last 6 months • Kidney or liver deseases

Before and after 12-weeks period of consistent pillow use, SW were assessed by capturing images using a 3D imaging system (LiveViz® Micro QuantifiCare). All image captures were conducted in a controlled environment, in the same room, under consistent lighting and temperature conditions (23°C +/- 1), and skin cleansing was performed prior to image capture. The diameter of the SW was measured based on clinical and roughness images provided by the Quantificare software. Three expert dermatologist graders conducted a visual grading of clinical improvement, categorizing the results into three levels: significant improvement, mid or moderate improvement, and no improvement or worsening of the SW.

The imaging of wrinkles was conducted using Quantificare® LiveViz Micro™, a compact and portable 3D system, adapted to a Nikon D5600 camera (**Figure 2**). This device incorporates integrated dual-beam light pointers to ensure enhanced image reproducibility. The images were visualized using DermaPix® software and SW roughness parameters (Rv, Rmax, Ra, Rz; **Table 2**) were analyzed through the 3D Analysis™ module, which allows for the assessment of minimal changes in the skin surface, reaching a resolution of up to 8 µm, and also enables volumetric measurements by analyzing structural changes in colorimetric and topographic features.

Figure 2. Quantificare® LiveViz Micro™

Table 2. Description of measured parameters of skin roughness

Parameter	Name	Definition
Rv	**Depth of deepest valley**	Maximum valley depth in surface profile, indicating the texture's deepest valleys and measuring pronounced irregularities from mean line to lowest point.
Rmax	**Maximum roughness depth**	Difference of the highest and deepest value of a single section of measurements.
Ra	**Arithmetic average**	Maximum peak-to-valley measurement across wrinkle assessment length, quantifying depth and surface irregularities.
Rz	**Mean roughness depth**	Arithmetic average of the difference of the highest and deepest value of a single section of measurements.

A univariate descriptive analysis of the sample characteristics was performed. For the quantitative variables, the usual central tendency and dispersion statistics (mean and standard deviation) were obtained, and qualitative variables were summarized by frequency and percentage for each category. The Shapiro-Wilk test was applied to check the normality of the diameter and roughness parameters of wrinkles and were described with mean and standard deviation. To compare the diameter and roughness parameters of wrinkles before and after the intervention, the student's t test for paired data was applied. They were treated as paired data since they were the same patients evaluated before and after the intervention. This type of tests allows us to consider the correlation that may exist between the measurements of the same patient before and after the intervention. The same comparisons were made before and after the intervention stratifying by age (< 50 years and ≥50 years), Glogau wrinkle scale (II, III, IV) and wrinkle location (front, cheek, other). All analyzes were performed with Stata version 17.0 statistical software and a significance level of 5% was considered for all tests.

RESULTS

Among the 24 volunteers initially recruited, 23 completed the study; one participant discontinued participation due to the inability to adjust to the pillow. Five patients were assessed for two wrinkles, resulting in the analysis of a total of 28 SW in different locations (front, cheek, paranasal, periocular and supralabial). All patients were assessed by expert dermatologists who determined the origin of the wrinkle through direct clinical evaluation and the *pillow test*,[4] which involves evaluating the suspected wrinkle by applying pressure with a hand or pillow to accentuate the wrinkle and differentiate it from expression lines. Wrinkles that disappeared a few hours after night rest were excluded. All volunteers used the pillow continuously for 12 weeks.

The age range of the volunteers who completed the study was between 37 and 61 years, with a median age of 50.8 years (SD=8) (see **Table 3**). All volunteers were assessed and categorized according to the Glogau scale: I (mild), II (moderate), III (advanced), IV (severe). Slightly more than half of the participants in the study (18 patients, 57.1%) belonged to group III. The wrinkle location was predominantly on the cheek in nearly half of the patients (12 patients, 42.9%). In 8 patients (28.6%), wrinkles were located on the forehead, and similarly, 8 patients (28.6%) presented with wrinkles in the paranasal, periocular, or supralabial areas.

Table 3. Description of characteristics of volunteers

	N = 28	%
Sex		
Male		
Female		
Age (years), Mean (SD)	50 (8)	
Age (years), n (%)		
< 50	16	57.1
≥ 50	12	42.9
Glogau wrinkle scale, n (%)		
II	6	21.4
III	18	57.1
IV	6	21.4
Location[1]		
Front	8	28.6
Cheek	12	42.9
Paranasal	3	10.7
Periocular	3	10.7
Supralabial	2	7.1
Location		
Front	8	28.6
Cheek	12	42.9
Other[2]	8	28.6

SD: Standard Deviation

[1] Right front (3), Left front (5), Right cheek (6), Left cheek (6), Right paranasal (2); Left paranasal (1), Right periocular (2), Left periocular (1), Right supralabial (), Left supralabial (2).

[2] Paranasal or Periocular or Supralabial.

After the use of the pillow, the mean diameter of the wrinkles decreased from 27.92 mm to 19.70 mm. The reduction of 29.4% was found to be statistically significant (p-value < 0.001). The mean value of Rv before the intervention was 0.19 mm, decreasing to 0.16 mm after the use of the pilow. This reduction of 15.8% was also statistically significant (p-value = 0.009). (**Table 4**).

A statistically significant reduction in wrinkle diameter was observed for both age groups. For patients under 50 years, the reduction was 30.4%, while for patients aged 50 years or older, the reduction was 27.9%. Furthermore, patients under 50 years of age showed a statistically significant reduction in Rv, Rmax, and Rz (Rv: p-value < 0.021; Rmax: p-value = 0.039; Rz: p-value = 0.049) as shown in **Table S1**.

Table 4. Diameter and roughness parameters of wrinkles before and after the use of the pillow.

	Before	After	*p-value*[1]	Decrement (%)†
Diameter (mm)	27,92 (12.39)	19.70 (10.01)	<0.001*	-29.4↓
Roughness parameters				
Rv (mm)	0.19 (0.06)	0.16 (0.10)	0.009*	-15.8↓
Rmax (mm)	0.34 (0.10)	0.35 (0.24)	0.253	+2.9
Ra (mm)	0.04 (0.02)	0.04 (0.02)	-	-
Rz (mm)	0.37 (0.10)	0.35 (0.24)	0.266	-5.4

The table shows the Mean (Standard Deviation).

[1] Student's t test for paired data

* Statistically significant difference when comparing before and after using the pillow (p-value < 0.05).

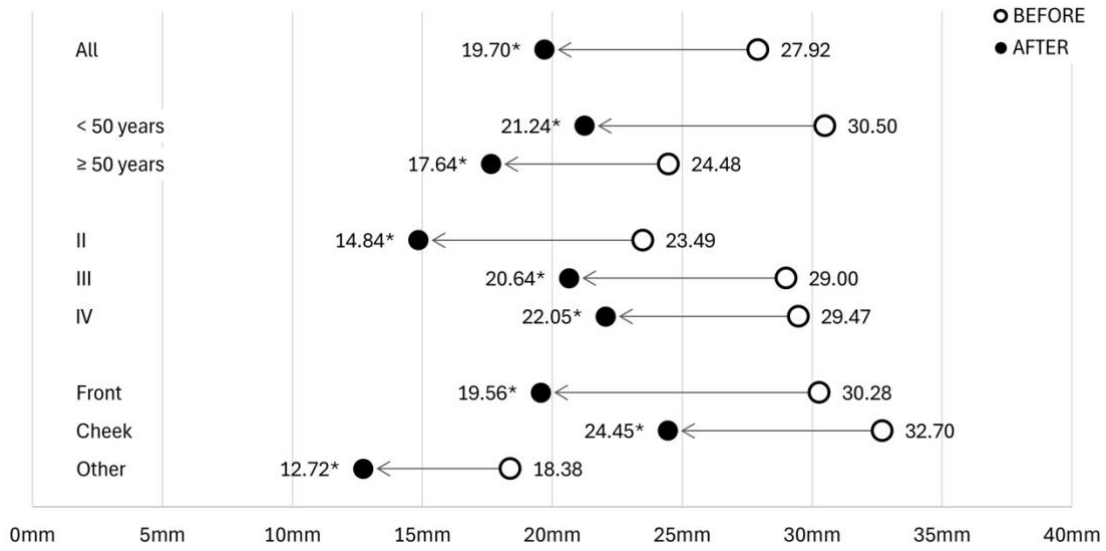
† Decrement (↓) of the mean value represents improvement of skin wrinkles.

Regarding the Glogau scale classification, a statistically significant reduction in parameters was observed across all groups. Specifically, for patients classified as Glogau II, the reduction in the diameter of the SW was 36.8%. For those with a Glogau III classification, a 28.8% reduction was noted, and for Glogau IV patients, the reduction was 25.2%. Rv, Rmax and Rz also showed improvement for SW at Glogau scale score of II or III (Rv II: p-value=0.05; Rv III: p-value=0.011; Rmax II: p-value = 0.002; Rmax III: p-value = 0.024; Rz II: p-value = 0.002; Rz III: p-value = 0.029), but not in patients with a score of IV (**Table S2**).

With respect to the location of the SW, for patients with forehead-located wrinkles, the reduction was 35.4%, while for those with cheek-located wrinkles it was 25.2%, and for patients with wrinkles in other locations (paranasal, periocular and supralabial), the reduction was 30.8%. Rv exhibited statistically significant improvement in wrinkles located in the paranasal, periocular, and suprabial regions (p-value 0.001). Rmax and Rz, did exhibit a statistically significant decrease in patients with forehead-located wrinkles and in other different locations (frontal Rmax: p-value = 0.013; other locations Rmax: p-value = 0.001; frontal Rz: p-value = 0.018; other locations Rz: p-value = 0.001) (**Table S3**).

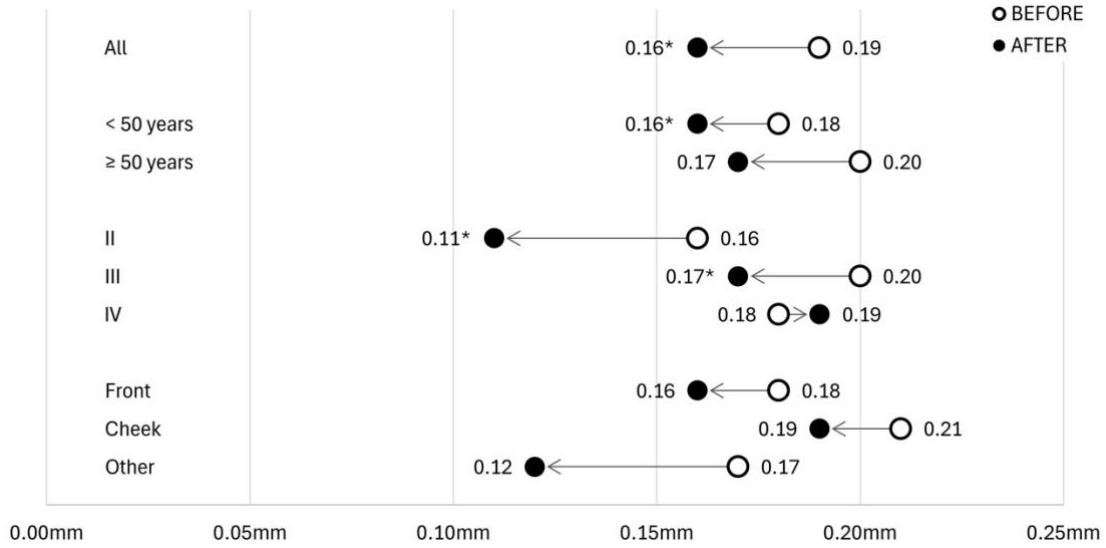
The improvement in diameter and Rv for the studied variables (age, Glogau scale score, and wrinkle location) is presented in **Figures 3 and 4. Figure 5** and **Figure 6** show patient 10 (right cheek) and patient 15 (left front), respectively, through 3D clinical images, overall roughness of the wrinkle area and the specific wrinkle's roughness at W0 and W12. All cases are presented in **Supplementary Material S2.**

Figure 3. Diameter of wrinkles before and after the intervention by age, Glogau wrinkle scale and winkle location.



* Statistically significant difference when comparing before and after using the pillow (p-value < 0.05).

Figure 4. Roughness parameter (Rv) of wrinkles before and after the intervention by age, Glogau wrinkle scale and winkle location.



* Statistically significant difference when comparing before and after using the pillow (p-value < 0.05).

According to the assessment by the three expert graders, 39.3% of the evaluated wrinkles exhibited significant improvement, 42.8% demonstrated moderate to slight improvement, and 17.9% did not improve or worsened. Based on this evaluation, 82.1%

of the assessed wrinkles showed some degree of improvement. No adverse reactions were observed throughout the study.

Figure 5. Clinical image, roughness image and roughness and wrinkle diameter on patient 10, at baseline (W0) and W12 (location: right cheek).

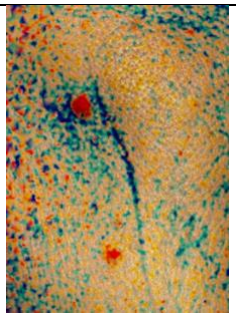
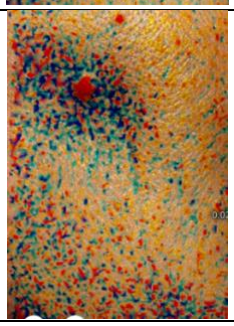
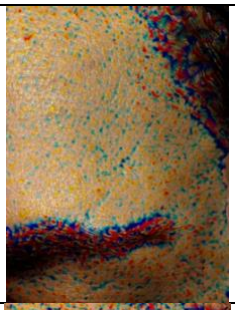
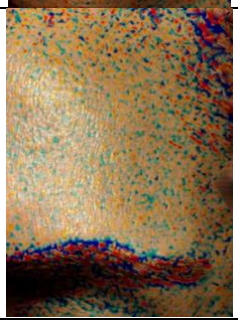
	Clinical image	**Roughness**	**Roughness and wrinkle diameter**
W0			
W12			

Figura 6. Clinical image, roughness image ad roughness and wrinkle diameter on patient 15, at baseline (W0) and W12 (location: left front)

	Clinical image	**Roughness**	**Roughness and wrinkle diameter**
W0			
W12			

DISCUSSION

The improvement of SW through the use of ergonomic pillows has been suggested in some publications. The only reliable way to minimize SW is to avoid facial distortion, and the use of pillows specially designed for this purpose appears to be a promising alternative.[6,7] To our knowledge, this is the largest study examining the effect of these pillows.

Patients underwent assessment by expert dermatologists who identified wrinkle origin through clinical evaluation and the *pillow test*. This analysis confirmed that the wrinkle was not an expression line and remained unchanged with facial muscle relaxation. Participants took between 2 and 6 weeks to adapt to the continuous nightly use of the pillow; a similar adaptation period as reported previously in the literature.[4]

The analysis of diameter and roughness parameters, conducted using high-precision equipment, revealed a significant improvement in SW following the use of specialized pillows for a duration of 12 weeks. This period aligns with the estimated timeframe for the improvement of these wrinkles as proposed by Steagman, the first author to describe these wrinkles and their likely association with night rest.[1] The mean diameter of the SW decreased by 29.4%, while the reduction in the Rv parameter was 15.8%

during this period, with both results being statistically significant. A decrease in the mean diameter value was also observed across all age groups, with a more pronounced reduction for patients under 50 years old. With age, the skin undergoes a loss of elasticity and stiffening, leading to the development of deeper wrinkles that, over time, become permanent. These results could be attributed to the greater skin elasticity and lower photoaging characteristics of younger skin, which may confer an enhanced capacity or speed of skin recovery following the removal of the mechanical stress that conventional pillows can exert on the skin. These results demonstrate the utility of the pillows in both younger patients and older patients with established wrinkles.

On the other hand, a more noticeable improvement in wrinkles was observed at lower scores on the Glogau scale, suggesting that the use of these pillows may yield better results in patients with less evidence of chronoaging and photoaging. The most frequent location of the analyzed wrinkles was the cheek (50% on the right cheek and 50% on the left cheek), The literature reports a preference for the population to sleep on the right side,[8,9] which is incongruent with our results, as our study found 46% of wrinkles in the right facial region and 54% in the left facial region. A significant improvement in SW was observed across all locations, and the most noticeable improvement was observed in the frontal region, for both diameter and roughness parameters, being statistically significant in both cases.

There are treatments that can temporarily improve the appearance of these wrinkles, such as the injection of dermal fillers. However, their effect is temporary and may lead to significant adverse effects, especially in certain locations.[10] The use of these ergonomic pillows appears to be a straightforward, safe, and more cost-effective method for the specific treatment to SW compared to these therapies, and we consider it a useful therapeutic strategy to prevent the progression of extrinsic aging.

The clinical assessment conducted by three expert graders revealed some degree of wrinkle improvement in 82% of cases, with a very significant enhancement in 39.3% of the SW evaluated.

One limitation of the study involves the potential artifacts generated by the Quantificare® LiveViz Micro™ program. To address this, multiple photographs were taken, enabling a large dataset for the comparative analysis at W0 and W12.

The findings of the study lead us to theorize that prolonged use of the ergonomic pillow could improve or even eliminate these wrinkles, depending on the patient's age and skin characteristics, but long-term studies are required to assess the alteration of these SW, its preventive role, and its potential to reverse them based on their location.

In conclusion, this study confirms our hypothesis that sleeping on ergonomic pillows improves the diameter and roughness of sleep wrinkles.

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