

*Short Paper***Effect of a fleecy woollen underlay on sleep**

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ABSTRACT: The folklore of ancient and modern cultures has recommended the use of wool as a bedding surface. In this article, the results of an experimental, repeated-measures study of the effect of a particular type of fleecy woollen sleeping surface on

observed and reported sleep are reported. This woollen underlay significantly reduced the observed postural activity and favourably influenced subjective estimates of sleep, compared with the control conditions.

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ONLY in relatively recent times have organizations and researchers started a serious investigation of the benefits of sleeping on wool. In 1964, the New Zealand Wool Board published a report on the use of fleecy sheepskins for the prevention of decubitus ulcers (bed sores).¹ A bedridden patient has most of his or her weight concentrated on pressure points such as the shoulder, hip, and heels. Trials in hospitals established that, when a patient slept either directly on a sheepskin or with a sheet in between, the fleece moulded around the contours of the body. This increased the area of contact of the body surface with the bedding, and such cushioning diffused pressure. Many hospitals and nursing homes now use sheepskins or, more commonly, a cheaper synthetic substitute called "silver-knit". The latter provides cushioning, but lacks the important absorbent property of wool. The advantages of diffusing pressure have also been established by research into the effectiveness of flotation devices, such as waterbeds and air-fluidized ceramic bead beds.^{2,3}

The published scientific reports in support of the other benefits of sleeping on wool have been, to date, rather limited. In one study, six symptom-free, but low birthweight, babies were observed on and off a woollen bedding surface.⁴ The surrounding air temperature was controlled and the babies' temperature was monitored, hence eliminating the influence of temperature on any reported differences in infant activity. The weight gain of the babies was significantly greater when they slept on wool, and the observational coding scheme suggested that minimal and moderate (but not vigorous) movement was reduced. The researchers concluded that the texture of the sleeping surface produced a soothing, swaddling effect which reduced stress on the infant, thus lowering metabolic activity. This, in turn, enabled greater weight gain. Another study of jaundiced babies tended to support the above-mentioned findings.⁵

A series of product trials and buyer surveys supervised by me over the period from 1980 to 1983 suggested that many adults also react positively to a woollen bedding surface. The mattress pad which was tested* was placed between the mattress and bottom sheet. Best described as a heavy pure wool blanket with a dense, tufted, fleecy woollen pile, it had received positive ratings from over 90% of about 700 users participating in six separate studies which were undertaken in New Zealand, Australia, the United Kingdom, and the United States. The majority of users reported sleep improvement, and a significant number of the elderly participants who suffered from various forms of arthritis, rheumatism, and back ailments reported improvement in sleep and consequential relief from various symptoms, such as stiffness and pain. Such results suggest, but do not constitute convincing scientific proof, that sleeping on a fleecy woollen mattress pad influences sleep. The study, the results of which are reported here, was undertaken with such an objective in mind.

Method

Time-lapse photography was used to record the body movement of participants sleeping in their own home or apartment. A Minolta X-700 camera, with a power drive and a programmable back, was housed in a polystyrene soundproofed box and positioned on a tripod at a distance of about 0.5 m to 1 m from the foot of the bed. A 7-watt night light provided sufficient illumination for XP-1 film using the highest speed setting on the camera (1600) and a time exposure of 15 seconds. The camera was programmed to take a 35-mm black and white picture of the subject automatically every 15 minutes throughout the night.

The experimenter initially positioned and focused the camera and loaded and unloaded the film. The participant was required to start the camera just before going to sleep and to turn the camera off upon rising in the morning. At that time, the participant also completed a questionnaire which recorded his or her evaluation of the night's sleep.

The technique is very similar to that used in a previous validation study in which six subjects slept for four consecutive nights in a

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* Woolrest Underlay[®]

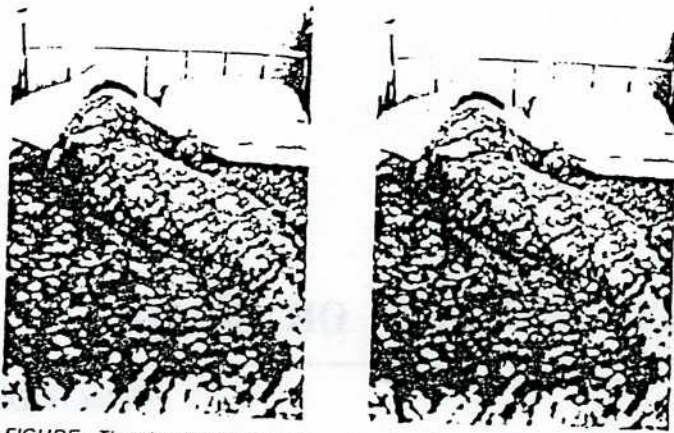


FIGURE. Time-lapse photographs of a sleeping subject: left taken at 3.41 a.m.; right taken at 3.56 a.m.

sleep laboratory.⁶ It was observed in that study that postural immobility (no change in position of trunk, head, or proximal limbs of the sleeper between adjacent photographs) was associated mainly with the descending, non-rapid-eye-movement phases of the sleep cycle. It is in these phases that the human physiological system is most relaxed.

Experimental protocol

Ten subjects participated in the study, each being their own control. Their sleep was recorded on three consecutive nights during which they slept on a control mattress pad and on three consecutive nights during which they slept on the underlay. The control and woollen pads were placed between the mattress and bottom sheet. During the first three nights, five of the participants slept on the control mattress pad and the other five slept on the woollen pad. Every subject was allowed to adjust to each mattress pad and to the night light for four nights. Because of the nature of the test surfaces, all subjects were aware that they were sleeping on different surfaces. (They were, however, unaware of the significance of these surfaces because they were not exposed to any promotional literature, nor was the experimental hypothesis explained to them.) Their sleep was recorded on the fifth to seventh nights of sleeping on the different surfaces. In three of the 10 cases, subjects were photographed sleeping with their spouses.

The small sample size is typical for sleep research studies, and the numbers were partially compensated for by the six repeated measures of subject's sleep. All of the subjects (nine men and one woman) were runners who ran an average of 6 km a day while participating in the study. They were a unique sample: because of their greater than usual daily physical activity, they were, by self-report, sound sleepers. Consequently, it can be assumed that this characteristic of the sample supports the conclusiveness of the results of this study, for, if bedding surface has an effect on the sleep of sound sleepers, it will very likely have a similar effect on sleep in most individuals. The second and third nights' sleep on the woollen underlay were not recorded in one subject because of equipment malfunction. This reduced the number of nightly observations from 60 to 58. Where a balanced design was required in the statistical testing of the effects of covariates, it was assumed that the woollen underlay produced identical sleep to that observed during the second and third nights this subject slept on the control surface. This approach resulted in an even more conservative assessment of the effect of bedding surface on sleep.

The postural activity between frames was coded as zero, minor, half-turn and full-turn. Any movement of the head, hand, foot, arm, or leg that was observed directly or indirectly (by a disturbance in the bed clothes) was coded as a minor movement. A half-turn was defined as a 90° turn of the trunk, and a full-turn

involved a 180° turn of the trunk between adjacent frames. A blind-coding process was used in which the coder was unaware of the treatment condition of the strip of film that was being coded. The specific directional hypothesis was that postural activity would be reduced when subjects slept on a woollen underlay. This entailed a statistical test of the null hypothesis that bedding surface had no effect on the various indicators of postural immobility.

Results

Both observational and self-report measures were used to evaluate the different bedding surfaces. The Table summarizes the results. There were statistically significant differences in the observed average number of immobile periods (no movement between consecutive photographs), the average number of immobile sequences, and the percentage of immobile periods in total time period spent sleeping on the woollen underlay, compared with the control surface. When the subjects slept on wool, they had, on average, over 20% more periods (15 minute periods of sleep) during which no body movement occurred. A popular belief is that the soundest and best sleep occurs early in the night's rest. The results of the study suggest that the number of immobile periods was greater during the first 10 time periods (2.5 hours), compared with later sleep. The woollen underlay also significantly reduced the gross movement periods (periods in which the subject made at least 90° turns) during the first 10 periods of the night's sleep.

The proportion of immobile sleep periods observed both in the control and in experimental conditions was lower than that reported in an earlier study,⁶ but there is no reason to believe that this difference threatens the validity of the findings. Given that the experimental subjects in the present study were, by self-report, sound sleepers, and only in three of the 60 nights did a subject indicate that the presence of the camera disturbed sleep, the difference is most likely to be the result of the conservative coding of immobile periods.

The subjects also reported feeling better in the morning, sleeping better than usual, and experiencing less than usual tossing and turning when sleeping on the woollen underlay. The average number of times that subjects reported waking

TABLE: Results of the experiment (average data)

	Control sleep surface	Woollen sleep surface
Observational measures		
Number of immobile periods	6.60	8.11*
Number of immobile sequences	4.97	5.89*
Proportion of immobile periods	23.8%	29.2%*
Number of immobile periods in the first 25 15-minute periods	6.27	7.61*
Number of gross movement periods in the first 25 15-minute periods	11.40	10.50
Number of immobile periods in the first 10 15-minute periods	3.40	4.11*
Number of gross movement periods in the first 10 15-minute periods	3.90	3.21*
Self-report measures (number of subjects)		
Feeling better in the morning	4.00	4.75*
Reported sleep quality	4.10	4.50*
Average number of times woke up	1.80	1.39
Reported tossing and turning	4.10	3.54*

* A statistically significant difference ($P < 0.05$) using appropriate within-subject, analysis of variance tests (BMDP2V).⁷

up during the night was in the expected direction (fewer), but this was not statistically significant.

To control for the effects of the previous day's variable physical and mental fatigue on the various sleep measures, subjects were asked whether they had worked or exercised physically harder than usual that day, whether they had worked mentally harder than usual, and what distance they had run. These measures were introduced as covariates into a within-subject repeated-measures analysis of variance. The effects of sleeping surface on sleep remained statistically significant. The testing order (whether control pad or woollen underlay was slept on first) did not have a significant effect on any of the measures.

While none of the subjects reacted adversely to the wool, it appeared that the experimental sleeping surface positively affected the sleep of four of the sleepers more than that of the remaining six. This suggests that unknown individual differences may moderate the effect of the sleeping surface on sleep. This is consistent with the findings of the field trials. While the woollen bedding surface was generally favourably rated, about 30% to 60% of subjects (varying from trial to trial) were extremely enthusiastic. In short, the experimental and field trials indicate that sleeping on the woollen underlay improves the sleep of some subjects more than that of others.

Discussion

This study is one of the first attempts to examine rigorously the claimed benefits of sleeping on a fleecy woollen bedding surface. Both the objective and the self-report measures indicated that the sleep of the respondents, who as a group were already sound sleepers, was significantly influenced by the bedding surface. The subjects slept better on the woollen underlay. The motor activity of sleepers is linked to electroencephalographic sleep-cycles,⁷ therefore bedding surface may also have an impact on many other

characteristics of sleep.

This experimental study helps confirm some of the claims made by users of woollen underlays. Why such underlays should have the effects that were observed is a question for future research. The following suggestions may singly, or very likely collectively, explain why sleeping on a woollen underlay influences sleep: (i) the fleecy woollen pile diffuses pressure points; (ii) the woollen fibres and pile trap air and insulate the sleeper, providing a consistent ambient temperature; (iii) the woollen fibres absorb and diffuse perspiration; and (iv) the woollen fibres, even when covered with a sheet, have a reassuring tactile advantage over standard bedding surfaces.

While this study reports positive findings, it would be interesting to undertake a similar study involving elderly sufferers from arthritis and rheumatism who report discomfort during sleep and upon arising in the morning. It is from this group that the strongest self-report testimonials have come. The applicability of the findings to other types of woollen bedding surfaces has yet to be established.

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