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Skin temperature of different body areas of the elderly without risk for pressure ulcer

Temperatura da pele de diferentes áreas corporais de idosos sem risco para lesões por pressão

Temperatura de la piel de diferentes áreas corporales de los ancianos sin riesgo de lesiones por presión

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Abstract: Objective: to identify the skin temperature of different body areas of elderly inpatients at a surgical clinic unit without risk of developing pressure injuries from the Braden Scale. **Method:** descriptive correlational study, with cross-sectional design, conducted at a surgical clinic unit of a university hospital from May to October 2017, with 84 patients. Descriptive statistical analysis was performed. **Results:** the sacral region presented the highest mean temperature and the right calcaneus, the lowest. There is no difference in skin temperature between the right and left sides in the scapulae, trochanters and calcaneus; between the sexes and races. When measured from 9:00 a.m. to 1:00 p.m., the temperature of the calcaneus was lower than when measured from 1:01 p.m. to 5:00 p.m. in the calcaneus region. **Conclusion:** the sacral region presents the highest mean skin temperature in relation to the areas measured. There is symmetry between the body sides.

Descriptors: Geriatric nursing; Skin; Skin temperature; Pressure ulcer; Aged

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Resumo: Objetivo: identificar a temperatura da pele de diferentes áreas corporais de idosos hospitalizados em unidade de clínica cirúrgica sem risco de desenvolver lesões por pressão a partir da Escala de Braden. **Método:** estudo correlacional descritivo, com corte transversal, realizado em unidade de clínica cirúrgica de um hospital universitário de maio a outubro de 2017, com 84 pacientes. Realizada análise estatística descritiva. **Resultados:** a região sacral apresentou média de temperatura mais alta e o calcâneo direito a mais baixa. Não há diferença na temperatura da pele entre os lados direito e esquerdo nas escápulas, trocânteres e calcâneo; entre os sexos e raças. Quando mensurada das 9:00 às 13:00h, a temperatura dos calcâneos foi menor do que quando mensurada das 13:01 às 17:00h na região dos calcâneos. **Conclusão:** a região sacral apresenta a média mais alta de temperatura da pele, em relação às áreas mensuradas. Há simetria entre os lados corporais.
Descritores: Enfermagem geriátrica; Pele; Temperatura cutânea; Lesão por pressão; Idoso

Resumen: Objetivo: identificar la temperatura de la piel de diferentes áreas corporales de ancianos hospitalizados en una unidad clínica quirúrgica sin riesgo de desarrollar lesiones por presión a partir de la Escala Braden. **Método:** estudio correlativo descriptivo, con sección transversal, realizado en una unidad clínica quirúrgica de un hospital universitario de mayo a octubre de 2017, con 84 pacientes. Se realizó un análisis estadístico descriptivo. **Resultados:** la región sacra presentó una temperatura media más alta y el calcáneo derecho tenía la más baja. No hay diferencia en la temperatura de la piel entre los lados derecho e izquierdo en las escápulas, trocánteres y calcáneos; entre los sexos y las razas. Cuando se mide de 9:00 a.m. a 1:00 p.m., la temperatura del calcáneo fue menor que cuando se midió de 1:01 p.m. a 5:00 p.m. en la región del calcáneo. **Conclusión:** la región sacra presenta la temperatura media más alta de la piel, en relación con las áreas medidas. Hay simetría entre los lados del cuerpo.
Descriptores: Enfermería geriátrica; Piel; Temperatura cutánea; Úlcera por presión; Anciano

Introduction

The human body has several protection processes against various aggressors. The skin, as the largest organ of the human body, has an important and efficient protective function in regulating body temperature and protects in relation to some physical factors such as moisture and mechanical forces – friction and shear. Skin cells are constantly renewed according to the exposure and region of the body.[1] As age advances, the skin becomes more fragile and its structures become less resistant to aggressor processes. The skin becomes more susceptible to the actions of the time, presenting risks of developing pressure injury: thin and dry skin, with the presence of edema, moist and sticky and sallow.[2]

Skin temperature is indicated in the literature as an important indirect risk factor for the development of pressure injuries (PIs), as it affects tissue tolerance to pressure and shear.[3-9] PI

can be defined as localized damage to the underlying skin and/or soft tissues, usually on a bony prominence or related to the use of a medical device or other artifact,[10] and may be considered as a public health problem,[11] since it has high incidence rates in hospitalization units (24.3%)[12] and in intensive care units (20.6%).[13]

Risk assessment is an important component of the clinical practice of professionals, which aims to identify individuals with characteristics that increase the probability of developing PI, which allows implementing a care plan to minimize risk factors.[14] Thus, the Braden scale stands out as one of the most used scales in the world. It was proposed by Braden and Bergstrom in 1987, based on a conceptual scheme that involves the risk and causal factors of PIs, and was also translated and validated in Brazil by Paranhos and Santos.[15]

In this sense, studies have pointed out that maintaining a lower temperature in areas of bone prominence seems to be a protective factor for the appearance of those lesions.[4-5,9,16] However, it is not yet known what the values would be considered "normal" for this variable.[9] In this sense, evaluating elderly patients, without risk of developing PI, can provide temperature values of cutaneous sites that may contribute, together with other studies, as clinical parameters, since it is not yet possible to state what are the values considered normal. What justifies the development of this research is the need to produce knowledge about the theme with different populations and scenarios so that, in the future, it is possible to establish reference values, which may guide actions in the clinical practice of nurses.

The patient's skin temperature and humidity (microclimate) are changed whenever he/she is positioned on a bed or chair, in contact with clothing, dressings or medical devices. The skin continuously adapts to those different conditions, thus extremes of high and low temperature and humidity negatively affect the skin barrier, contributing to a higher risk of PI. The specific parameters of those variables and possible upper and lower thresholds are currently unknown, but they are expected to be specific to the population and skin area.[9]

In this context, the research question is: in elderly inpatients at a surgical clinic unit without risk of developing pressure injuries from the Braden Scale, what is the skin temperature in different body areas? The study aimed to identify the skin temperature of different body areas of elderly inpatients at a surgical clinic unit without risk of developing pressure injuries from the Braden Scale.

Method

This is a descriptive correlational study,[17] with cross-sectional design. The matrix project aimed to identify the skin temperature of different body areas of patients hospitalized in a surgical clinic unit, without risk of developing pressure injury. For the analysis of the present study, only elderly patients (from 60 years of age) were included.[18]

The research was carried out in a surgical clinic unit of a university hospital in southern Brazil. The unit has 52 beds and assists patients of high complexity in the pre and postoperative specialties of general surgery, traumatology, head and neck, thoracic, proctology, urology and vascular.

Hospitalized patients who participated in the matrix project in the surgical clinic unit met the following inclusion criteria:

a) patients without risk of developing pressure injuries using the Braden Scale (19 to 23 points);
b) age greater than or equal to 18 years.

The exclusion criteria were:

a) presence of pressure injury in the measurement areas of the variables;
b) amputation of a limb; presence of bandage, plaster splint or fixative that would prevent access to the measurement sites of the variables;
c) altered level of consciousness or difficulty in communication and without a companion;
d) with the presence of edema in the measurement sites of the variables.

To perform the sample calculation of the matrix project, the Epi Info™ program was used for descriptive studies, considering a statistical power of 80%, a significance level of 95% ($\alpha < 0.05$), population size of 574 (estimated number of patients hospitalized in the surgical clinic unit in one year and without risk of developing PI), expected frequency of change in skin temperature of 50% and margin of error of 5 percentage points. Thus, the result of the sample calculation was 230 patients. In this analysis, all elderly patients were included in the matrix project database, totaling 84 patients, through authorization from the responsible researcher.

The data collection team consisted of three nurses, nursing postgraduate students and three scientific initiation students, who were nursing students. Prior to the beginning of data collection, all collectors received theoretical and practical training, based on the collector's handbook, which was elaborated by the researchers to serve as a guide for the collection of the research data.

Data collection began in May 2017, with successive entry of individuals who met the selection criteria. Daily visits were made to the surgical clinic unit to recruit the participants, through verbal invitation. The last participant was recruited in October 2017.

Data were collected with the aid of a data collection form elaborated in Epi Info™ on a mobile device (Tablet), with the following variables: age (in complete years); collection time (in hours, minutes and seconds); gender (female and male); self-reported race (white and black/brown); Braden Scale score; ambient temperature (in °C); humidity of the environment (in %); skin temperature (in °C) of different body areas with bony prominences – scapulae, elbows, trochanters and calcaneus bilaterally, occipital and sacral.

The areas of bone prominence were chosen for being the sites most prone to the development of PI. They are anatomical sites where the forces of friction (perpendicular) and shear (tangential), produce greater damage to soft tissues, making them more vulnerable to the appearance of PI.[19] The choice of patients without risk of developing PI is due to the fact that it produces clinical parameters of normal temperature for those body areas, being important to

emphasize that there is limited information on normal skin temperature on anatomical sites prone to the development of pressure injuries.[9] The surgical clinic service was selected for being the hospital unit where patients remain hospitalized and, mainly, during the preoperative period, they do not have a risk of developing PI. The choice of elderly patients occurred because old age is a risk factor for the development of PI.[19-20]

A digital thermohygrometer was used to measure the temperature and humidity of the environment. For the measurement of skin temperature, the infrared thermograph with one-point laser was positioned seven centimeters away from the skin[6] in the aforementioned areas of bony prominences; between 9:00 and 17:00.

The data were transferred from Epi Info™ to Microsoft Excel spreadsheet and analyzed with the help of the Statistical Package for the Social Science (SPSS) for Windows, version 21. Descriptive statistical analysis was performed using measures of central tendency (mean and median), dispersion (standard deviation and interquartile interval) and proportion according to the nature of the variables. For the analysis of the normality distribution, the Shapiro-Wilk normality test and bivariate data analysis were used. To verify the relationship between the independent variables and the skin temperature, the Student's t-test (data with normal distribution, two independent groups) or U of Mann-Whitney (absence of normality, two independent groups) was used; Friedman's ANOVA (no normality, more than two dependent groups) and Wilcoxon's post hoc were used.

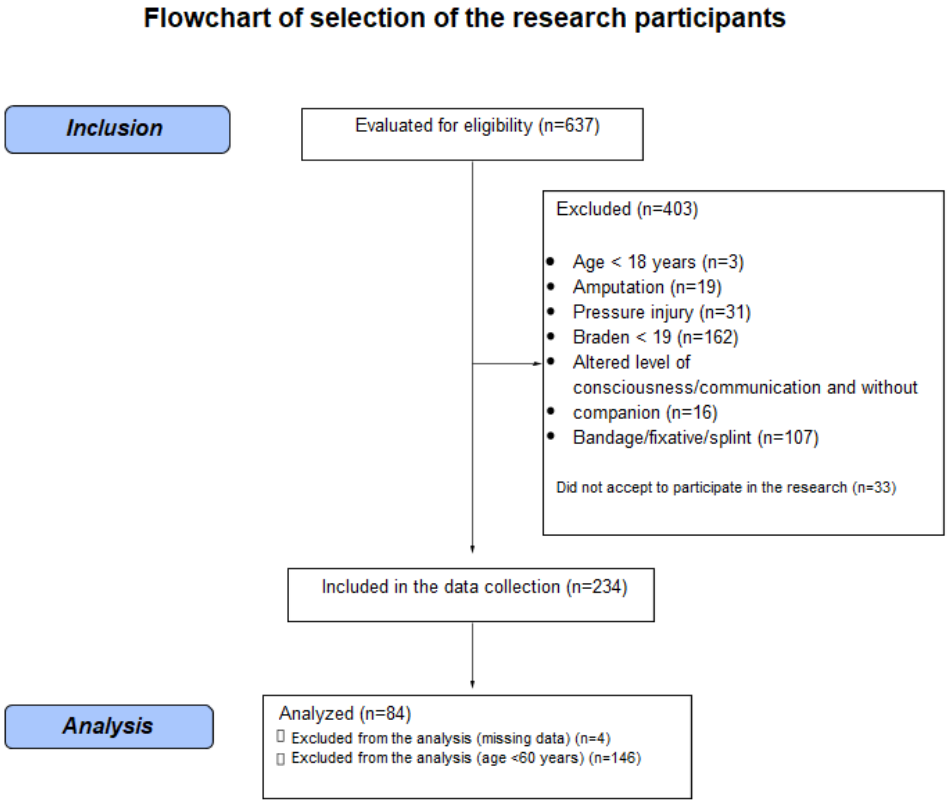
The correlation between the quantitative variables was verified through Spearman's correlation. The interpretation of the correlation was performed based on the Tumb Rule, considering as a very high correlation when values of r from 0.90 to 1.00 were obtained; high from 0.70 to 0.90; moderate from 0.50 to 0.70; low from 0.30 to 0.50; and insignificant of 0.00.[18] For the purpose of analysis, a significance level of 5% was used.

Following the rules and regulatory guidelines of research in human beings, the research project was approved by the Research Ethics Committee under opinion n. 2.014.558 and Certificate of Presentation for Ethical Appreciation n. 66615417.9.0000.5346. The participants of the primary research were informed about the development of the research and their anonymity was guaranteed; those who agreed to participate signed two copies of the Informed Consent Form, being one of them delivered to the participant.

Results

For eligibility, 637 hospitalized patients were evaluated; after applying the selection criteria, 234 were included in the collection. For this analysis, four were excluded due to missing data and 146 due to age (<60 years), including 84 participants – Figure 1.

Figure 1 – Flowchart of selection of the participants of the research on skin temperature in elderly inpatients at a surgical clinic without risk of developing pressure injury, Santa Maria, RS, Brazil, 2017



Eighty-four individuals were evaluated, who were characterized by the predominance of males (65.5%), white race (79.8%) and age between 60 and 88 years, with a mean of 69.3±6.9 years (Table 1). Regarding the time at which the variables were measured, the majority (76.2%) was evaluated at the time from 01:01 p.m. to 05:00 p.m. Table 1 also shows the final score of the Braden scale, presenting a score that points to the absence of risk in relation to the development of PI (22.2±1.2) points, with a variation of 19 to 23. Regarding the temperature and humidity of the environment, the means were 24.0°C and 64.0% respectively.

Table 1 – Distribution of elderly inpatients at a surgical clinic unit without risk of developing pressure injuries according to the variables gender, race, time of measurements, age, Braden Scale score, temperature and ambient humidity (n = 84). Santa Maria, RS, Brazil, 2017.

Variable	n	(%)
Gender		
Male	55	65.5
Female	29	34.5
Race		
White	67	79.8
Brown	11	13.1
Black	6	7.1
Time of measurements		
From 9:00 a.m. to 01:00 p.m.	20	23.8
From 01:01 p.m. to 05:00 p.m.	64	76.2
	Mean±SD*(Min†-Max‡)	
Age (years)	69.3±6.9(60-88)	
Braden Scale Score	22.2±1.2(19-23)	
Ambient temperature (°C)	24.0±2.3(18.1-29.4)	
Ambient humidity (%)	64.0±9.9(38.0-86.0)	

* SD=Standard Deviation; † Min=Minimum value; ‡ Max=Maximum value

Regarding the temperature of the body areas of bony prominences evaluated (Table 2), the sacral region presented the highest mean temperature (34.5±1.8), ranging from 25.7°C to 38.0°C. The right calcaneus region presented the lowest average (28.1±2.9), with a minimum temperature of 22.5°C and maximum of 33.9°C.

Table 2 shows that there is a significant difference (p<0.001) between the skin temperature of all body regions, except between the right and left sides in the regions: scapulae, trochanters and calcaneus. This absence of significant difference between the body sides indicates symmetry between the right and left sides; for this reason, the other analyses were performed with the mean temperature between the sides of the respective body areas. No difference was found between trochanter skin temperatures and occipital region.

Table 2 – Comparison between body areas and skin temperature in elderly inpatients at a surgical clinic without risk of developing pressure injury (n = 84). Santa Maria, RS, Brazil, 2017.

Body areas	Skin temperature (°C)		p-value¶	Significant differences**
	Mean±SD* (Min†-Max‡)	M§ (IQ‖)		
Occipital	32.4±1.6 (27.9-35.9)	32.5(1.9)	<0.001	Occipital ≠ all areas; except left and right trochanter
Left shoulder blade	33.6±1.6 (29.5-36.8)	33.7(2.3)		Left scapula ≠ all areas; except right scapula
Right scapula	33.7±1.6 (28.1-36.7)	34.0(2.5)		Right scapula ≠ all areas; except left scapula
Left elbow	31.4±1.6 (23.4-35.8)	31.6(2.2)		Left elbow ≠ all areas
Right elbow	31.2±1.5 (27.1-34.6)	31.1(2.3)		Right elbow ≠ all areas
Sacral	34.5±1.8 (25.7-38.0)	35.0(2.0)		Sacral ≠ all regions
Left trochanter	32.8±1.5 (28.8-35.9)	33.0(1.9)		Left trochanter ≠ all areas; except right and occipital trochanter
Right trochanter	32.9±1.6 (27.5-35.9)	33.0(2.3)		Change right ≠ all areas; except left and occipital trochanter
Left calcaneus	28.4±2.7 (20.5-33.8)	28.3(3.6)		Left calcaneus ≠ all areas; except right calcaneus
Right calcaneus	28.1±2.9 (22.5-33.9)	28.0(4.3)		Right calcaneus ≠ all areas; except left calcaneus

* SD=Standard Deviation; † Min=Minimum value; ‡ Max=Maximum value; § M=Median; || IQ=Interquartile Range;¶ Friedman's ANOVA Test, **Wilcoxon's *post hoc* test, considering a significance level of 5%

As described in Table 3, there is no significant difference in skin temperature between female and male, between the self-reported white and brown/black races. Regarding the time of measurement of skin temperature, the measurement from 9:00 a.m. to 01:00 p.m. was significantly lower than that measured from 01:01 p.m. to 05:00 p.m. in the calcaneus region, p=0.005.

Table 3 – Comparison between gender, race, time of measurement and skin temperature in different body areas in elderly inpatients at a surgical clinic unit without risk of developing pressure injury (n = 84). Santa Maria, RS, Brazil, 2017.

Body areas	Skin temperature (°C) by gender		p-value
	Female	Male	
	Mean±SD*	Mean±SD	
Occipital	31.9±2.1	32.6±1.2	0.087‡
Scapulae	33.4±1.6	33.8±1.5	0.268‡
Elbows	31.4±1.3	31.2±1.5	0.378†
Sacral	33.9±2.4	34.8±1.3	0.071†
Trochanters	32.6±1.2	33.0±1.5	0.233‡
Calcaneus	27.9±4.9	28.5±2.8	0.352‡
Body areas	**Skin temperature (°C) by race**		**p-value**
	White	Brown/black	
	Mean±SD	Mean±SD	
Occipital	32.4±1.6	32.4±1.6	0.639†
Scapulae	33.7±1.6	33.4±1.2	0.449‡
Elbows	31.3±1.5	31.2±1.3	0.987‡
Sacral	34.6±1.6	34.3±2.4	0.941†
Trochanters	32.8±1.5	33.0±0.9	0.703‡
Calcaneus	28.4±2.5	27.6±3.1	0.228‡
Body areas	**Skin temperature (°C) measured at different times**		**p-value**
	9:00 a.m.-01:00 p.m.	01:01 p.m.-05:00 p.m.	
	Mean±SD	Mean±SD	
Occipital	32.0±1.6	32.5±1.6	0.682†
Scapulae	33.6±1.7	33.7±1.5	0.679‡
Elbows	30.9±1.3	31.4±1.4	0.157‡
Sacral	34.3±1.8	34.6±1.8	0.194†
Trochanters	32.3±1.3	33.0±1.4	0.089‡
Calcaneus	27.0±1.9	28.7±2.7	0.004‡

*SD=Standard deviation; †Mann-Whitney U Test, considering a level of significance of 5%. ‡Student's T Test, considering a level of significance of 5%.

Table 4 presents correlation data between age, ambient temperature, ambient humidity and skin temperature in different body areas of the elderly.

Table 4 – Correlation between age, ambient temperature, ambient humidity and skin temperature in different body areas in elderly inpatients at a surgical clinic unit without risk of developing pressure injury (n = 84). Santa Maria, RS, Brazil, 2017.

Area of measurement of skin temperature	Age		Ambient temperature		Ambient humidity	
	ρ*	p-value	ρ	p-value	ρ	p-value
Occipital	0.011	0.921	0.355†	0.001	-0.078	0.482
Scapulae	-0.133	0.227	-0.063	0.571	0.088	0.426
Elbows	0.071	0.523	0.207	0.059	-0.160	0.145
Sacral	-0.061	0.579	0.069	0.534	0.014	0.899
Trochanters	-0.065	0.555	-0.069	0.535	0.047	0.674
Calcaneus	0.020	0.857	0.220†	0.044	-0.237†	0.030

*ρ: Spearman's Correlation Coefficient. †Significant correlations, at a significance level of 5%.

A low positive correlation was found between the skin temperature of the occipital region and the ambient temperature (ρ=0.355; p=0.001). The correlations between calcaneus temperature and ambient temperature, and between calcaneus temperature and ambient humidity, are considered insignificant (ρ<0.300; p<0.05) – Table 4.

Discussion

Epidemiological data indicate that PIs occur in all age groups, but are associated with increasing age.[21] The skin is an organ consisting of layers: epidermis and dermis. The stratum corneum is the outermost layer of the epidermis, thus being the first layer directly affected by any change in temperature or humidity.[9] Skin temperature is a physiological measure that can serve as a clinical parameter in the prevention of PI, since an increase of 1.2°C in 24 to 96 hours can occur before the appearance of PI.[22]

Advancing age promotes several profound transformations in the skin. A greater skin fragility and lower ability to act as a barrier against external factors stand out in the elderly. The skin is drier and rougher due to the reduced number of sebaceous glands, decreased elasticity,

sagging, altered cellular immune response and decreased thickness of the dermis and epidermis, increasing the risk of lesions.[23]

A study carried out aiming to determine the heat distribution in the upper and lower limbs in a healthy adult population shows that there is a general symmetry in terms of average temperatures for both sides of the participants' bodies.[24] Therefore, it corroborates the findings of this study, since this symmetry between the body sides was also identified.

It is noteworthy that, even though there is symmetry in the values of temperatures between the body sides, it is observed that there is a significant difference ($p<0.001$) between the skin temperature of all body regions. However, the findings of another study stand out, which show that the mean temperatures on both sides of the participants were similar at the extremities, such as toes and hands and palm and plantar surfaces. ($P<0.05$).[24]

The average ambient temperature and humidity in this research were 24.0°C and 64% respectively; those conditions were similar to other studies conducted with patients hospitalized in intensive care units[6] and with healthy workers of the Brazilian Air Force. Regarding the temperature of the different body areas, the skin temperature of the sacral region (34.5°C) and right (28.1°C) and left (28.4°C) calcaneus stands out, as they are considered places with a higher incidence of PI.[25]

The calcaneus region is more prone to the development of lesions. The area of the contact surface in the heel is small and has little subcutaneous tissue, and the pressure is exerted directly on the calcaneus bone. Associated with this characteristic, vascular properties lead the pressure applied to the region to cause a serious impairment to the perfusion.[26]

A study developed with the objective of comparing the skin temperature of physically active older and young women using thermography between the body sides shows that older women have higher skin temperature than young women do, and the greatest differences are concentrated in peripheral regions of the body, such as the hands. Regardless of age group,

there is a bilateral thermal symmetry generally below 0.5 °C in young and old women. However, older women have higher skin temperature values than young women in most of the regions evaluated, especially in the distal regions of the limbs.[27]

In this study, there is no significant difference in skin temperature between females and males. With university students, a research was carried out in seven body sites (arm, chest, back, belly, waist, thigh and leg), which investigated skin temperature and heat flow in laboratory environment. With the increase in ambient temperature from 25 to 31 ° C, local skin temperatures also increased gradually. The skin temperature of the waist and belly for the female group were higher than for the male group. The skin temperatures of the legs, thighs and back for both groups were similar.[28]

Regarding the time of measurement of skin temperature, the measurement from 9:00 a.m. to 01:00 p.m. was significantly lower than that measured from 01:01 p.m. to 05:00 p.m. in the calcaneus region. This finding is in line with the results of another study, which signals a different behavior of temperature in different areas of the body, with variations between late afternoon and evening, noting higher temperatures at 11:00 p.m.[29] This fact may be associated with the influence of circadian rhythm, which is defined as the physiological, metabolic and behavioral changes that occur in the human body in the 24-hour period. It is controlled by the suprachiasmatic nucleus (SCN) of the anterior hypothalamus and is greatly influenced by light and the environment.[30]

Circadian rhythm controls our body temperature and skin temperature. The central body temperature is higher during the day, when compared to the nighttime, with a decrease in the early morning; on the other hand, the skin presents an increase in temperature in the afternoon with a decrease at night, which corroborates the findings of this study.[30]

Skin temperature assessment is a strategy that can help healthcare professionals detect altered metabolic activity. An increase in this variable results in a 10% increase in cellular

metabolism, which in turn leads to tissue damage since it reduces blood flow.[22] Therefore, its measurement helps in predicting risk for pressure injury.[3-8,22]

Thus, in the context of the prevention of PIs, the findings of this study are important to strengthen temperature reference values for each body region, since, as known, altered skin temperature may occur prior to the appearance of clinical manifestations in the skin related to PI.[7-8]

More studies evaluating the correlation between age and skin temperature should be carried out, in addition to studying the influence of temperature and humidity of the environment on skin temperature of different body areas. This study has, as a limitation, non-probabilistic sampling, and may configure a bias in the selection of the research participants.

Conclusion

The measurements of skin temperature allowed verifying the following parameters of the different body areas: the sacral region presented the highest mean temperature (34.5±1.8), while the right calcaneus region presented the lowest mean (28.1±2.9). All regions measured present differences in temperature, except the right and left sides in the scapulae, trochanters and calcaneus, indicating symmetry between the sides of the body and between the occipital region and the trochanters. Regarding measurement times, it is noteworthy that the measurements performed in the afternoon (01:01 p.m. to 05:00 p.m.) presented higher temperatures in the calcaneus region.

The results found contribute to the advancement of knowledge about the skin temperature of the elderly, with important implications for the management of care related to the prevention of pressure injury in this population. The objective is the knowledge produced to facilitate the clinical decision-making of the professional in his/her daily practice, since there is evidence that changes in skin temperature suggest the appearance of PI.

Thus, this study presents data from different areas of bone prominence of the elderly population, which are the areas and individuals at higher risk of developing PI. Thus, the evidenced data may serve as clinical parameters for future meta-analyses on the subject.

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