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Capacity of a sweat patch method to detect the effect of an antiperspirant

Capacidad del método de parches de sudoración para detectar el efecto de un antitranspirante

Capacidade do método de adesivos de suor para detectar o efeito dum antitranspirante

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Luis Fernando Aragón-Vargas  ²

Abstract: An effective antiperspirant is supposed to reduce sweat production by up to 50%, according to the manufacturers, but the scientific evidence in the literature is limited; possibly, the actual reduction may be so small that it may not be detected by conventional methods. The purpose of this study was to verify if the sweat patch method was able to detect the reduction in regional sweat loss that would be expected from using an antiperspirant. In addition, the magnitude of the effect was quantified. We verified the impact of an antiperspirant (condition A, skin treated with the product) on localized scapular sweat rate during 20 minutes of exercise at 78-80% HRmax, at $29.7 \pm 0.5^{\circ}\text{C}$ ambient temperature and $54 \pm 3.4\%$ relative humidity, compared with a control condition (C, untreated skin). A statistically significant difference in scapular sweat rate was found between conditions: $A = 14.6 \pm 10.3 \mu\text{L} \cdot \text{min}^{-1}$ and $C = 19.2 \pm 12.6 \mu\text{L} \cdot \text{min}^{-1}$ ($p = 0.001$). This means that the participants secreted approximately 24% less sweat when using an antiperspirant, compared with the intact skin, as measured by the sweat patch method.

Keywords: aluminum chloride, sweat sheets, body lotion, thermoregulation.

Resumen: Un antitranspirante efectivo es supuestamente capaz de disminuir la sudoración hasta en un 50%, como lo afirman las compañías que fabrican estos productos, pero hay poca evidencia publicada al respecto; es posible que la disminución real sea tan pequeña que no pueda ser detectada por los métodos convencionales. El propósito de este estudio fue verificar si el método de parches de sudoración es capaz de mostrar una disminución en la tasa de sudoración localizada que debería ocurrir por el uso de un antitranspirante. Además, se midió la magnitud de este efecto. La influencia esperada del antitranspirante (condición A, piel rociada con antitranspirante) se verificó con base en la tasa de sudoración localizada de la zona escapular durante 20 minutos de ejercicio a una intensidad entre 78 y 80 % de la FCmáx con una temperatura ambiental promedio de $29,7 \pm 0,5^{\circ}\text{C}$ y una humedad relativa de $54 \pm 3,4 \%$, comparada con una condición control (C) (piel sin antitranspirante). Por consiguiente, se encontraron diferencias estadísticamente significativas entre las condiciones $A = 14,6 \pm 10,3 \mu\text{L} \cdot \text{min}^{-1}$ y $C = 19,2 \pm 12,6 \mu\text{L} \cdot \text{min}^{-1}$ ($p = 0,001$) en la tasa de sudoración de la zona escapular, lo cual significa que los participantes sudaron aproximadamente un 24 % menos cuando se les aplicó

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antitranspirante comparado con la piel intacta, según las mediciones obtenidas con el método de parches de sudoración.

Palabras clave: cloruro de aluminio, láminas de sudor, loción corporal, termorregulación

Resumo: Supõe-se que um antitranspirante efetivo é capaz de diminuir o suor até 50% como afirmam as companhias que fabricam isto produtos, mas são poucas evidências a respeito do mesmo: é possível que a real diminuição seja pequena não podendo ser detectada com métodos convencionais. O objetivo deste estudo foi verificar se o método de adesivos de suor é capaz de detectar a diminuição da taxa de transpiração localizada que deve ocorrer a través da utilização de um antitranspirante. Além disso, a magnitude do efeito foi medido. Verificou-se a influencia que tem o antitranspirante (Condição A, pele rociada com antitranspirante) na taxa de sudoração localizada da zona escapular durante 20 minutos de exercícios na intensidade entre 78% e 80% da FCmax com temperatura ambiental media de $29.7 \pm 0.5^{\circ}\text{C}$ e humidade relativa de $54 \pm 3.4\%$, comparado com uma condição controle (C) (pele sim antitranspirante). Controlaram-se diferenças estatisticamente significativas entre as condições $A = 14.6 \pm 10.3 \mu\text{L} \cdot \text{min}^{-1}$ y $C = 19.2 \pm 12.6 \mu\text{L} \cdot \text{min}^{-1}$ ($p = 0.001$) na taxa de sudoração da zona escapular, ou seja, que os participantes suaram aproximadamente 24% menos quando se aplico antitranspirante comparado com a pele intata, de acordo com as medições obtidas com as adisivos de suor.

Palavras-chave: cloreto de aluminio, manchas de suor, loção para o corpo, termorregulação.

1. Introduction

Thermoregulation during physical activity has been studied in detail for approximately one hundred years (Burton, [1934](#)). Since then, a limited number of studies have been conducted on localized sweat rate (LSR) (Bain, Deren & Jay, [2011](#)). One method used to collect sweat from a specific area of the body involves using sweat patches, which were originally used by authorities to detect drugs in the body (Phillips & McAllon, [2008](#)). Their use was so effective for sweat collection that they became an indispensable material in some areas of thermoregulation, particularly in studies related to sports (Havenith, Fogarty, Bartlett, Smith & Ventenat, [2008](#); Morris, Cramer, Hodder, Havenith & Jay, [2013](#); Shirreffs, Aragón-Vargas, Chamorro, Maughan, Serratos & Zachwieja, [2005](#)).

Therefore, it would be very useful to verify whether the sweat patch method, modified from Maughan, Merson, Broad & Shirreffs ([2004](#)), is sufficiently sensitive to detect small differences in localized sweat rates obtained under moderate exercise conditions. One way to induce these differences would be to apply an antiperspirant, as this substance would be expected to decrease the sweat rate. It should be noted that this method (patches) is commonly used in conditions of intense exercise in heat and profuse sweating to measure electrolyte concentrations, not to compare sweat rates.

Some previous research has used antiperspirant on people with hyperhidrosis (excessive sweating) (Reynolds, et al., [1995](#); Schmidt-Rose, et al., [2013](#)). In these studies, subjects were only evaluated for sweating rates on their hands, feet, and armpits while they were subjected to

psychosocial stress or very low-intensity exercise such as walking. In psychosocial stress studies (in which sweat patches were used), all three types of antiperspirants (*roll-on*, aerosol, and stick) were found to be effective in reducing localized sweating when subjects were subjected to social stress through a mental test (Schmidt- Rose, et al., [2013](#)). However, in low-intensity exercise studies (where the garment is weighed before and after the test), no statistically significant differences were found between skin sprayed with antiperspirant and skin without antiperspirant when subjects walked on a treadmill (1.39 m/sec, 1% incline) in a hot environment (28 °C, 25% relative humidity) for 200 minutes (Reynolds, et al., [1995](#)).

There is also another study under high-intensity exercise conditions in which researchers found no significant differences in sweat rate with or without the use of antiperspirant (Burry, Evans, Rawlings & Shiu, [2003](#)). These studies have several methodological limitations that could have influenced the results, such as lack of control of exercise intensity and hydration status, among others.

Due to the need to verify the ability of the patch method to detect small changes in regional sweating as a result of the use of body lotions, and based on the logic that applying antiperspirant to the skin should decrease the rate of sweating in that area, the present experiment was designed to verify whether this method is capable of detecting the expected decrease in the rate of sweating when an antiperspirant is applied to the skin and exercise of moderate- to high-intensity is performed in the heat for 20 minutes. This method could be very useful for manufacturers of antiperspirants and sunscreen lotions widely used in the world of sports, but it would also allow for the evaluation of the impact of different clothing or sports equipment on thermoregulation.

2. Methods

Participants

Ten university students (seven men and three women) who were physically active, apparently healthy, and without skin problems were voluntarily recruited for this study. Participants were instructed not to take any medication or eat any foods considered diuretics the day before the study. They were also asked to drink at least 1 liter of water the day before the session to ensure that the sample was as homogeneous as possible in terms of hydration. Each participant wore sports clothing (the women wore cross-back tops to keep the shoulder region uncovered; the men wore nothing on their upper body).

Procedure

The research was conducted in a single session for each participant, which included both scapular areas (left and right) for the antiperspirant condition (A) and the control condition (C) (skin covered with lotion and skin without lotion, respectively). The treatment was randomly assigned to each scapular region (left or right). At the start of the session, each participant was given an informed consent form and a physical fitness questionnaire "Par-Q" (Adams, [1999](#)), which they completed and signed voluntarily. They were also asked to provide a urine sample to determine specific gravity (USG) using a handheld refractometer (URC/Ne, ATAGO® , Tokyo, Japan), according to the method described by Aragón-Vargas, Moncada-Jiménez, Hernández,

Barrenechea, and Monge-Alvarado (2009).

For hydration, the results of the study by Oppliger and Bartok (2002) were used as a parameter: if the urine specific gravity was greater than or equal to 1.020, the participant was considered to be in a state of hypohydration and was not allowed to participate in the session. The body weight of each participant was measured, completely naked, on a calibrated scale (e-Accura®, model DSB291, Romanas Ballar, Costa Rica) and recorded to the nearest 10 g (they were also weighed at the end of the session). Next, both shoulder areas were cleaned with gauze and distilled water (the gauze was soaked three times and excess water was removed with dry gauze, applying pressure without rubbing). The scapular region was selected because it is an area where there is usually no hair, it is one of the areas with the highest perspiration, and, according to Havenith, Fogarty, Bartlett, Smith, and Ventenat (2008), and Smith and Havenith (2011), it is a region that perspires the same as the contralateral area, allowing both sides of that region to be used. To select the exact point for patch placement, the upper parallel edge of the left scapular point was identified, and then the right edge in the same way, according to the ISAK manual of international standards for anthropometric assessment (International Society for the Advancement of Kinanthropometry, 2001, p. 32) (see Figure 1).

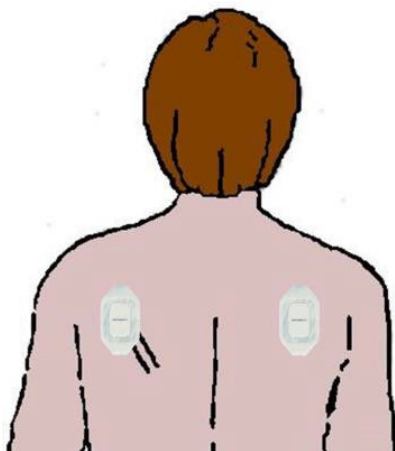


Figure 1. Location where the sweat patches were placed. For a more detailed description, see the ISAK manual (International Society for the Advancement of Kinanthropometry, 2001, p. 32). Source: own elaboration based on <http://www.ugr.es/~jhuertas/EvaluacionFisiologica/Antropometria/antroppliegues.htm>

Once the scapular points were identified, they were marked with waterproof eyeliner (Revlon® ColorStyle, New York City, New York, United States), using stencils designed to apply the lotion precisely to the predefined areas so that it would not interfere with the adhesive part of the patches. Once the areas were clean and marked, an antiperspirant lotion containing aluminum chloride (Rexona™ V8 Tuning, Australia) was applied with the help of the stencil and left to dry for 60 minutes (the optimal time determined in a pilot test) while the subjects remained at rest outside the climate-controlled room under ambient conditions of 28.2 ± 0.9 °C and $55.1 \pm 2.2\%$ relative humidity. After 60 minutes, excess antiperspirant was removed with a dry gauze pad and a $4.9 \times$

3.3 cm = 16.17 cm² sweat collection patch (MSX - 6446, 3M, Brookings, S.D., United States) was applied. Nothing was applied to the side corresponding to the control condition; only the patch was placed on the marked area when the other was placed on the opposite side. When each patch was applied, a separate stopwatch was started to obtain the exact time the patch was on the skin (t). The subjects then exercised on stationary bicycles in a climate-controlled room (ambient temperature = 29.7 ± 0.5 °C, relative humidity = 54 ± 3.4%) for 20 minutes at a moderate-high intensity between 78 and 80% of maximum heart rate, which was calculated according to the equation: HRmax = (207 - 0.7 * age) proposed by Gellish, Goslin, Olson, McDonald, Russi, and Moudgil (2007). The intensity was verified with heart rate monitors (Polar® FT4, Kempele, Finland). The weight of the patches was measured with a precision scale (A&D GX - 200, Toshima-ku, Tokyo, Japan), before and immediately after removal (after 20 minutes). For this procedure, the sweat collection method used by Maughan et al. (2004) and Smith and Havenith (2011) was modified. The method consists of:

1.- Placing each patch in a small plastic bag with a tight seal (to prevent sweat from evaporating) for weighing before and after the test.

2.- Once the patches have been placed in the bag, it is folded (taking care not to fold the patch) and a metal clip is attached to prevent the plastic bag from expanding and changing the weight.

3.- Once both results are available (weight of the patch before and after the test), subtract one from the other to obtain a value. This value (weight gain in grams) represents the amount of sweat absorbed by the patch in a stipulated time, where one gram of water is considered equivalent to one milliliter, and the value is taken as a volume of sweat. This volume was standardized, divided by the time elapsed between the two weight measures, and multiplied by 1,000 to report $\mu\text{L} \cdot \text{min}^{-1}$. The weight difference in micrograms and the time in minutes and seconds that each patch was in place (t) were recorded, and the sweat rate was calculated as follows: $\Delta \text{weight} \cdot t^{-1}$.

Statistical analysis

To characterize the sample, descriptive statistics were performed for age, body weight (before and after), height, t, urine specific gravity (USG), and maximum heart rate of the subjects (see Table 1). A one-way ANOVA was performed for related samples, with the condition (A or C) as the independent variable and the sweat rate as the dependent variable.



3. Results

Table 1.
Characteristics of the subjects

	Men (n= 7)	Women (n= 3)	Total (n= 10)
Age (years)	21.6± 3.1	18.7± 1.2	20.7± 2.9
Height (cm)	176.0± 9.3	159.2± 2.0	170.9± 11.1
Pre-weight (kg)	74.90± 13.90	51.40± 1.40	69.34± 15.41
Post-weight (kg)	74.60± 14.00	51.10± 1.30	68.96± 15.39
USG	1.017± 0.004	1.012± 0.006	1.015± 0.005
Max HR (beats/min)	191.8± 2.0	193.5± 0.4	192.3± 1.8
t (min)	20.96± 0.77	21.06± 0.58	20.99± 0.70

Note: USG (urine specific gravity); t (time the patch was in place, in minutes). Source: the authors.

Statistically significant differences were found in the sweat rate of the scapular area between conditions: ($19.2 \pm 12.6 \mu\text{L} \cdot \text{min}^{-1}$ vs. $14.6 \pm 10.3 \mu\text{L} \cdot \text{min}^{-1}$ for C and A, respectively) ($p = 0.001$), i.e., subjects sweated less when antiperspirant was applied compared to skin without antiperspirant (see [Figure 2](#)).

4. Discussion

The most important finding of this study was that the patch method is indeed capable of detecting the expected decrease in sweat rate when an antiperspirant is applied to the skin and moderate-to-vigorous exercise is performed in the heat for 20 minutes. The antiperspirant inhibited sweat production, which reduced perspiration by approximately 24% compared to the control area (without antiperspirant).

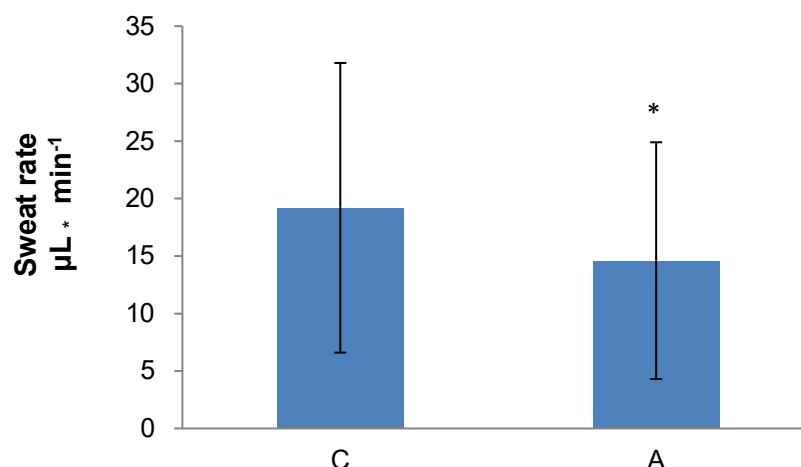


Figure 2. Results of one-way ANOVA. C> A. Without antiperspirant (C) ($19.2 \pm 12.6 \mu\text{L} \cdot \text{min}^{-1}$), with antiperspirant (A) ($14.6 \pm 10.3 \mu\text{L} \cdot \text{min}^{-1}$); *p = 0.001

In a study published by Burry, Evans, Rawling, and Shiu (2003), two groups of 11 subjects were asked to exercise for 45 minutes on a cycle ergometer in a climate-controlled room (35°C and 20% relative humidity). In the first session, deodorant was applied after 14 days of no antiperspirant product use under the arms, according to the subjects. The second session was conducted seven days after the first, and a standard commercial antiperspirant was used. The researchers found no significant differences in sweat rate (measured generally by the subject's weight before and after exercise) or body temperature between the antiperspirant and the deodorant. In this study, the researchers defined exercise intensity as that which each participant was able to maintain in a previous test for 45 minutes, without exceeding HRmax - 10 beats per minute. They did not mention the composition of the products used or whether they were allowed to dry after application to the skin. In addition, the authors did not monitor hydration status of the subjects (it was not measured), they did not have a control group, and they did not randomize.

The present study, on the other hand, was carefully designed to properly control most potential sources of error: by taking both measurements at the same time and on the same person, the body temperature and hydration status of each participant were identical for both conditions, as were the exercise time and environmental conditions. The randomization of antiperspirant assignment to one side or the other, as well as previous evidence indicating no differences in sweat rate between the right and left scapular areas (Havenith et al., 2008, Smith & Havenith, 2011), complete the robustness of the design. Finally, it is acknowledged that a weakness of the method presented is that it does not describe how a standardized amount of antiperspirant can be applied each time, which would be essential for some research applications.. However, this test demonstrates that it is feasible to detect the expected effect of an antiperspirant on the sweat rate using the patch method.

English translation: This manuscript was translated using *DeepL-Pro*; the translation was

reviewed and corrected by Luis Fernando Aragón V., Ph.D., FACSM, School of Physical Education and Sports, University of Costa Rica, Costa Rica.

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