

ORIGINAL ARTICLE

A new sunscreen application technique to protect more efficiently from ultraviolet radiation

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Key words:

sun damage; sun protection; sunscreen

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Accepted for publication:

9 September 2014

Conflicts of interest:

None declared.

Funding:

Vichy Laboratories.

SUMMARY**Background**

UV radiation protection is an important health issue. Sophisticated sunscreen formulations have been developed to improve compliance. However, sunscreen is still inadequately applied, leaving large body areas without effective protection.

Aim

This study aims to validate a newly developed sunscreen application technique for adults and children.

Methods

Fifty-eight volunteers were recruited to participate in a monocenter, intraindividual, sequential, comparative study. The covering potential of their currently used sunscreen application technique and of a newly developed systematized application technique (Dose, Apply, Spread) were compared. Evaluation criteria included the amount of product applied, the homogeneity of sunscreen application as measured by the Wood's lamp, and the volunteers' appreciation of the new technique.

Results

Fifty-eight volunteers participated in the study: 20 women, 19 men, and 19 children. Respecting the new application technique resulted in a statistically significant ($P < 0.05$) more evenly spread sunscreen on the different parts of the body and an increase in the amount of product applied. Furthermore, the body surface area covered was significantly increased ($P < 0.05$), and the new technique was well perceived and accepted by the volunteers.

Conclusion

The proposed new application technique ensures that more sunscreen will be used and that it will be applied more evenly. Educational work could help improve the efficient use of sunscreens, therefore providing better UV protection.

Photodermatol Photoimmunol Photomed 2014; 30: 323–331

The primary environmental factor that causes human skin aging is ultraviolet (UV) irradiation from the sun. Individuals who have outdoor lifestyles, live in sunny climates, and have fair phototypes will experience the greatest degree of photoaging (1). Face, neck, legs, and the dorsal hands get the most sunlight exposure and are hence exposed to an increased risk of photodamage such as skin cancer and photoaging (2).

Nonmelanoma skin cancers are the most common types of cancer in the white population and represent a serious health burden in sun-exposed populations (2, 3). Regular sunscreen use, together with avoiding sun exposure during the sun's zenith and wearing clothes, is one of the most important actions to prevent skin cancer and other photodamages (4).

The most common method for evaluating sunscreen protection potential is the measure of their efficacy to prevent sunburn, based on the ratio of the minimal erythema dose of the protected skin vs. the unprotected skin (4). However, to achieve the degree of photoprotection mentioned on the label, at least 2 mg/cm² of the sunscreen must be applied (5). Unfortunately, studies have shown that users apply much less than this (on average 0.5 mg/cm²) when intentionally exposing themselves to the sun (2, 3, 6, 7). The reasons for this include a reported sticky/greasy sensation and lack of knowledge on how to apply sunscreen correctly (4, 8). Furthermore, the desire for a quick tan and consciously ignoring the side effects may also play an important role.

The present study aimed to assess the efficacy and the ease of a new sunscreen application technique to see whether it could be approved by the French Society of Photodermatology.

MATERIALS AND METHODS

An intraindividual, sequential, comparative study was conducted from March to May 2012 at one investigational site in France.

Nineteen men, 20 women, and 19 children were recruited. Adult volunteers had to be in good health, aged 18–50 years, using sunscreens. Children had to be aged 4–10 years, in good health, and with parents regularly using sunscreens for their child. The adults and parents had to have an educational level, allowing them to read and understand instructions in French (DNB (diplôme national du brevet) level). Prior to inclusion, volunteers, or their legal representatives, provided written informed consent.

Evaluation criteria included:

- Amount of product applied.

- Homogeneity of sunscreen spread over different parts of the body.
- Omitted skin surface areas.
- Volunteers' appreciation of the new technique.

On the morning of the study, the volunteers were not allowed to put on any makeup or use skin care products and they had to wear swimsuits (men and boys) or bikinis (women and girls) during the application session.

First, the volunteers were asked to apply the provided sunscreen (unlabeled sunscreen product, SPF 30) to themselves or to their child in their usual application way.

Homogeneity of sunscreen applied and the skin surface area covered with sunscreen were assessed by the dermatologist investigator by the Wood lamp method using UV-light (9, 10). Photographs were also taken; the body surface area was calculated using the Mosteller formula for children and the Dubois formula for adults (11, 12). The dermatologist had to fill in a questionnaire regarding the application on each area (face, chest, arms, back, shoulders, legs, and feet) with four level of ratings for the quality of homogeneity (not at all homogeneous, not homogeneous, globally homogeneous, and perfectly homogeneous). The dermatologist also calculated and noted for each subject the surface of the areas that had not been covered by sunscreen.

After showering with provided unlabeled shower products, and after drying themselves, the volunteers were given instructions on the new application technique. They were invited to watch a video and to follow a detailed visual instruction (Fig. 1a–c). The new technique is a systematized technique dividing the body and face into different segments in order not to forget any zone, which really differs from the conventional technique. This systematized application technique comprised three steps: I: dose (visualization of teaspoons to reach the correct amount for each body segment), II: apply (application of the total dose on several uniformly spaced spots for each body segment), and III: spread (with circular moves for an even application for each body segment). This new application technique has been developed for different galenic preparations: creams, milks, and sprays.

The volunteers were then given a new bottle of an identical sunscreen (unlabeled sunscreen product, SPF 30, milk galenic preparation) and were asked to apply it following the proposed new systematized application technique.

The homogeneity of the product application and the skin surface areas covered by the sunscreen were again assessed using the Wood lamp procedure, and photographs were taken.

Sunscreen bottles were weighed before and after application in order to calculate the total amount of product

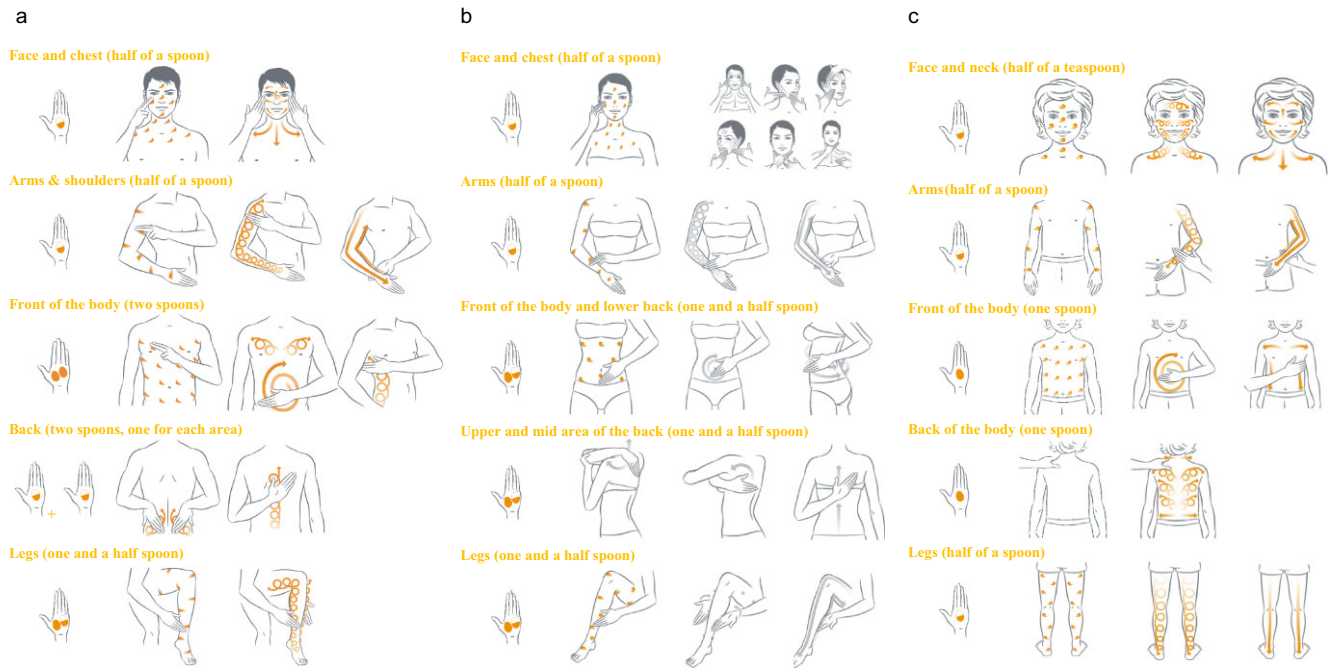


Fig. 1. New application method. (a) Men. Face and chest (half of a spoon). Arms and shoulders (half of a spoon). Front of the body (two spoons). Back (two spoons, one for each area). Legs (one and a half spoon). (b) Women. Face and chest (half of a spoon). Arms (half of a spoon). Front of the body and lower back (one and a half spoon). Upper and mid area of the back (one and a half spoon). Legs (one and a half spoon). (c) Children. Face and neck (half of a teaspoon). Arms (half of a spoon). Front of the body (one spoon). Back of the body (one spoon). Legs (half of a spoon).

applied as well as the amount of product applied per cm² of body surface area covered.

At the end, the volunteers completed a questionnaire about the ease and efficiency of the new technique (Table 1).

Statistical methods used

Descriptive statistical analyses were used for homogeneity of application, the percentage of volunteers that omitted skin areas, applied product amounts, and volunteers' appreciation. The *t*-test was used to analyze and compare the difference of the surface of skin areas omitted and the difference of the applied product amounts.

The chi-square test was used to analyze and compare the difference of homogeneity between the application techniques determined by the dermatologist investigator.

RESULTS

Demographics and baseline data

Fifty-eight healthy volunteers participated in this study: 20 women, 19 men, and 19 children. Of the volunteers included in the study, 52.6% of the men and 60% of the women reported that they usually applied their sunscreen

Table 1. Questionnaire completed by the volunteers

The new application technique is easy to understand.
The new application technique is easy to follow.
Spoon-dosing of the product on the palm of my hand is easy to understand.
Spoon-dosing of the product on the palm of my hand is easy to do.
Applying small quantities of the product on the different parts of the body is easy to understand.
The technique does not omit any part of the body or face.
The new application technique makes me apply more product than I would normally do.
The new application technique is easy to do.
The new application technique makes me feel more protected.
I will continue to follow the new application technique.

*I totally agree.

†I agree.

‡I do not agree.

§I do not agree at all.

adequately. This rate reached 94.7% in children, according to their parents.

Detailed demographics and baseline data for each population are provided in Table 2.

Table 2. Demographics and characteristics at inclusion

	Men	Women	Children
Number of volunteers, <i>n</i>	19	20	19 10 girls 9 boys
Age, years			
Mean ± SD	33.2 ± 10.7	38.2 ± 9.1	7.1 ± 2.3
Phototype, <i>n</i> (%)			
I	0 (0)	4 (20.0)	6 (31.6)
II	6 (31.6)	6 (30.0)	6 (31.6)
III	8 (42.1)	7 (35.0)	6 (31.6)
IV	3 (15.8)	1 (5.0)	1 (5.3)
V	2 (10.5)	2 (10.0)	0 (0)
Skintype, face, <i>n</i> (%)			
Normal	10 (52.6)	15 (75.0)	16 (84.2)
Dry	6 (31.6)	3 (15.0)	2 (10.5)
Oily/combination	3 (15.8)	2 (10.0)	1 (5.3)
Skintype, body, <i>n</i> (%)			
Normal	10 (52.6)	17 (85.0)	18 (94.7)
Dry	7 (36.8)	3 (15.0)	1 (5.3)
Oily	2 (10.5)	0 (0)	0 (0)
Sun protection behaviors, <i>n</i> (%)*			
Use of sunscreen	19 (100.0)	20 (100.0)	19 (100.0)
Consider that sunscreen is adequately applied	10 (52.6)	12 (60)	18 (94.7)
Report regular sunburn	13 (68.4)	10 (50.0)	2 (10.5)

*Figures do not add up to 100% as multiple answers were permitted.

Homogeneity of application

In all cases (men, women, and children), the sunscreen was spread more evenly when using the new application technique compared with the usual technique as observed by the dermatologist using the Wood lamp. The difference was statistically significant (all $P < 0.05$) for the middle, upper back and shoulders for men and women (100% perfectly and globally homogeneous dermatological ratings for the new technique vs. 21.1% with the usual technique $P = 0.04$ and 100% perfectly and globally homogeneous dermatological ratings vs. 55% with the usual technique $P = 0.013$) and for the face and ears of the children (100% perfectly and globally homogeneous dermatological ratings for the new technique vs. 52.6% with the usual technique $P = 0.04$).

Photographs taken of a throat, back, and thigh show these differences in Fig. 2.

Skin surface areas covered and forgotten

The new application technique allowed men to significantly forget fewer areas. Indeed, with the new technique, 78.9% of the men did not forget any area of their face vs. 42.1% with the usual technique, 100% of the men did not

forget any area of the front of the body vs. 52.6%, and 42.1% of the men did not forget any area of the back of the body vs. 10.5% compared with their usual technique. However, to a certain extent, they still forgot their nose/nose wings as well as the area between the eyebrows (both 10.5% of the men), the middle of the back (for 57.9%), and the upper thighs (5.3). Details are provided in Fig. 3a–c.

Similar results were obtained in children: The new application technique allowed parents to significantly forget fewer areas in their child. Indeed, with the new technique, 68.4% of the parents did not forget any area of the face vs. 21.1% with the usual technique, 100% of the parents did not forget any area of the front of the body vs. 57.9%, and 94.7% of the parents did not forget any area of the back of the body vs. 63.2% compared with their usual technique. Overall, only 5.3% vs. 42.1% of parents omitted the nose/nose wings when following the new technique, and only 5.2% vs. 15.8% omitted the area behind their child's thighs (details are provided in Fig. 4a–c).

The new application technique allowed women to significantly forget fewer areas. Indeed, with the new technique, 50% of women did not forget any area of their face vs. 15% with the usual technique, 80% of the women did not forget any area of the front of the body vs. 30%, and

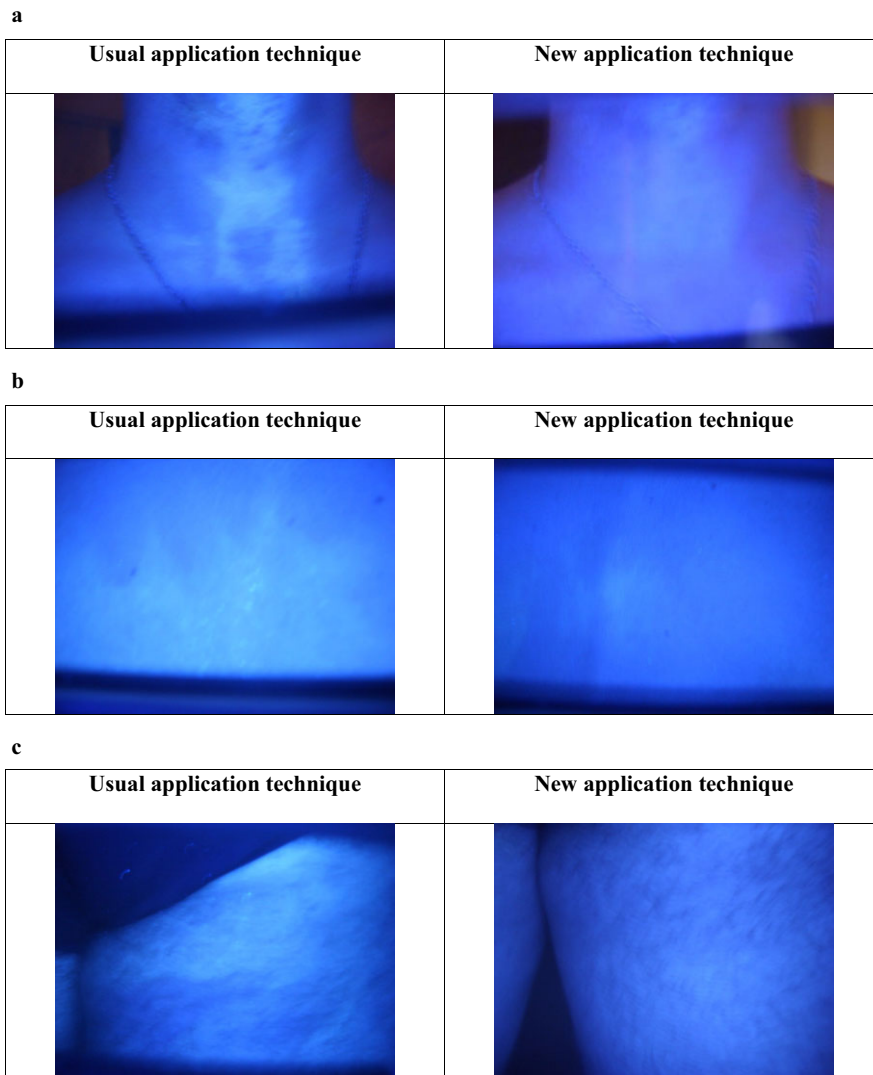


Fig. 2. Difference in homogeneity of sunscreen product applied. (a) Upper chest/throat of a male volunteer. Usual application technique. New application technique. (b) Back of a female volunteer. Usual application technique. New application technique. (c) Thigh of male volunteer. Usual application technique. New application technique.

50% of the women did not forget any area of the back of the body vs. 20% compared with their usual technique. They mainly forgot to protect parts of their face (ears, nose/nose wings, areas around the eyebrows, and corners of the eyes), armpits, edges of the swimsuit, and their back. Details are provided in Fig. 5a–c.

Table 3 provides detailed results of the mean skin surface area forgotten as calculated by the dermatologist investigator, showing a clear and significant improvement in favor of the new application technique in men, women, and children.

Total amount of product applied

When respecting the new application technique, more sunscreen was significantly applied by all the volunteers,

and more sunscreen per skin area covered was also applied. The results show a mean increase of 48.2% in children, 51.3% in men, and 61.5% in women, giving an overall mean quantity of at least 1 mg/cm² of sunscreen applied when adjusted for the body surface area. Detailed information is provided in Table 4.

Evaluation of the new application technique

Almost all the volunteers agreed that the new application technique was easy to understand (> 90%) and to follow (> 84%). Furthermore, a majority of the volunteers (> 73%) confirmed that they felt that they were better protected from UV radiation and confirmed that they would continue to follow this new application technique in the future.

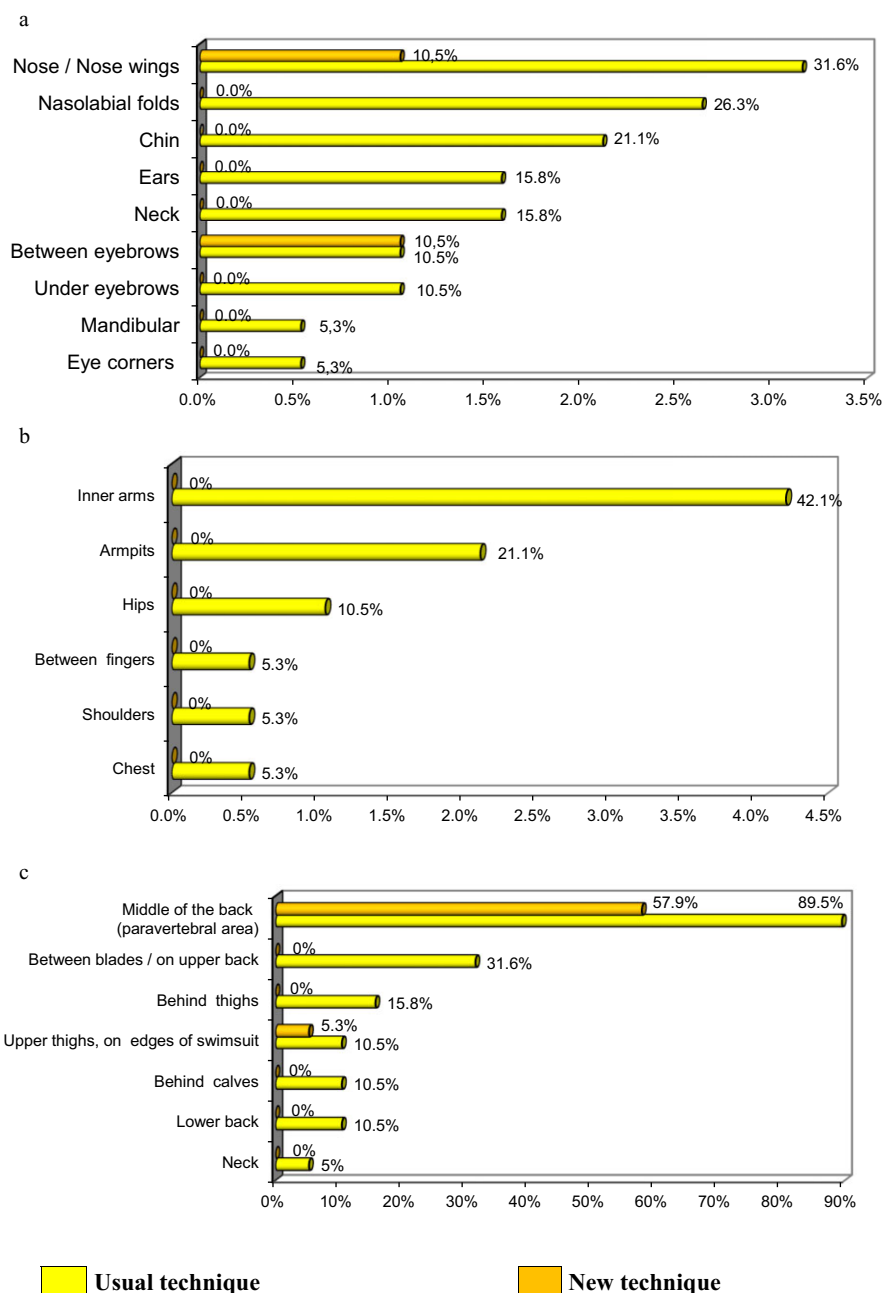


Fig. 3. Percentage of men forgetting to cover skin areas. (a) Face. (b) Front of the body. (c) Back of the body.

DISCUSSION

More sophisticated sunscreen formulations have been developed during recent years. Technical advances have been made in order to make them spread more easily and different textures are available: milk, cream, fluid, or sprays. They make the user's skin feel less sticky or greasy. However, adequate application of sunscreen is still an issue. Sunscreens have to be applied evenly and in sufficient quantities to achieve optimal protection. Already in 1996, Diffey *et al.* reported that people did not apply suf-

ficient sunscreen, and it seems that this situation has not changed (13). This was confirmed by Azurida *et al.* in 1999 and 2000 in photosensitive patients (8, 14). Their investigations demonstrated that poor application techniques resulted in far less product being applied than what is ideally necessary (i.e. 2 mg/cm² or 35 ml for the whole of an adult's body) to efficiently cover the skin. They further demonstrated that adequate education can considerably improve the previously poor application techniques (14).

With the results of this comparative study, we demonstrated that the use of an adequate and easy-to-follow

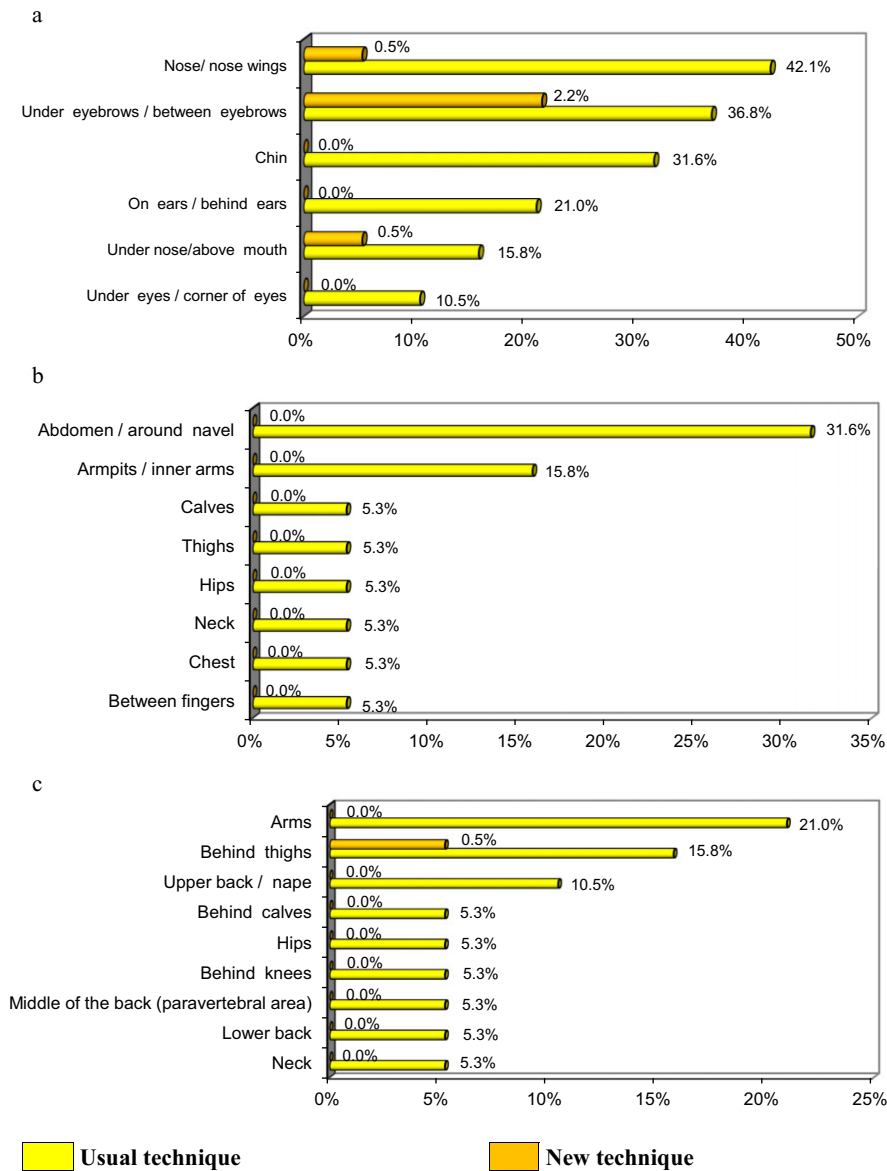


Fig. 4. Percentage of parents forgetting to cover skin areas in children. (a) Face. (b) Front of the body. (c) Back of the body.

Table 3. Mean surface of skin surface areas forgotten to be covered

	Usual technique	New Technique	
	Mean surface ± SD (cm ²)	Mean surface ± SD (cm ²)	P-value
Men			
Face	4.4 ± 5.1	0.5 ± 1.3	0.025
Front	7.4 ± 9.9	0 ± 0	0.001
Back	50.0 ± 51.5	9.7 ± 10.9	0.009
Women			
Face	6.7 ± 5.1	1.5 ± 2.0	0.001
Front	16.8 ± 17.4	1.2 ± 2.7	0.001
Back	70.0 ± 92.8	7.1 ± 9.0	0.003
Children			
Face	7.4 ± 6.5	0.9 ± 1.6	0.02
Front	7.6 ± 15.1	0 ± 0	0.02
Back	10.0 ± 17.1	0.3 ± 1.1	0.013

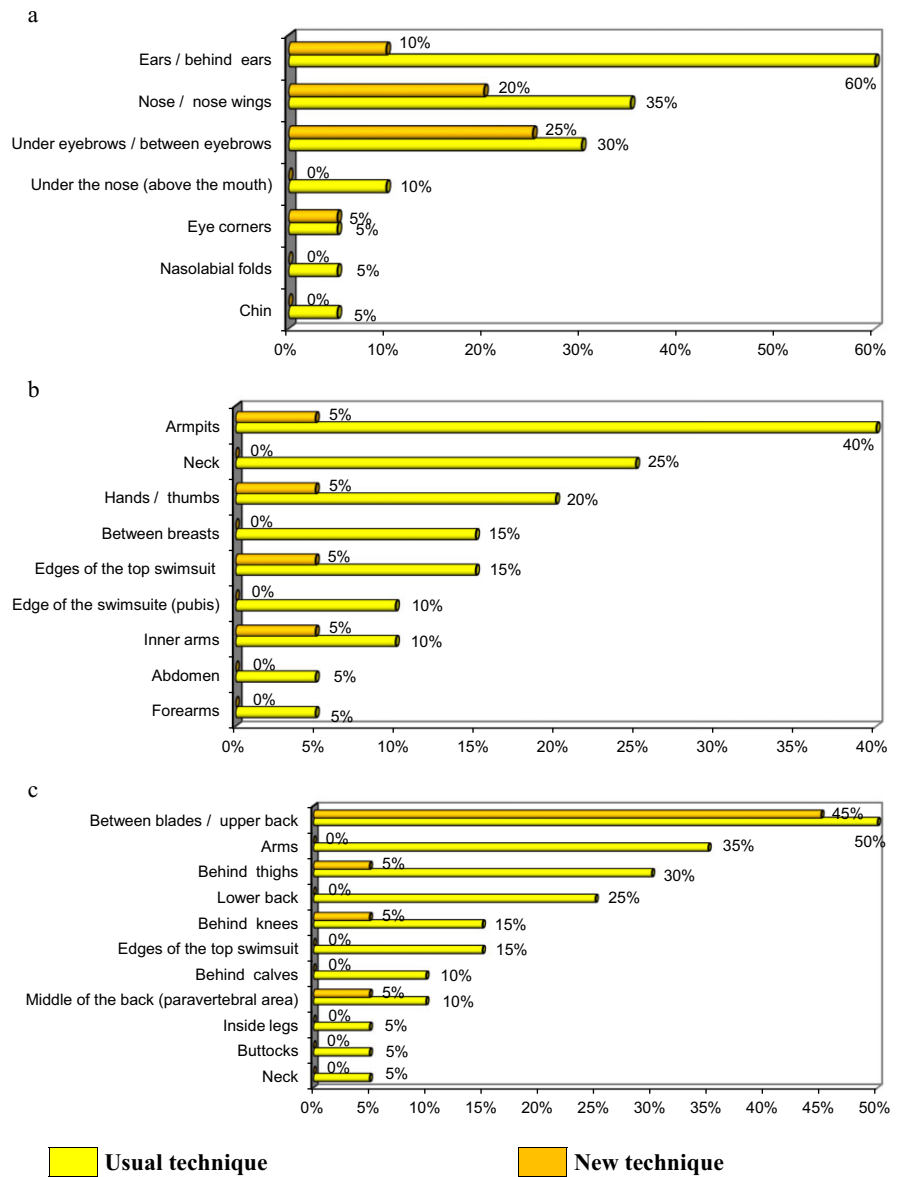


Fig. 5. Percentage of women forgetting to cover skin areas. (a) Face. (b) Front of the body. (c) Back of the body.

Table 4. Mean total quantity of product applied (g and mg/cm²)

	Usual technique (mean ± SD)	New technique (mean ± SD)	P-value
Male volunteers	11.9 ± 5.4 g 0.6 mg/cm ²	18.0 ± 7.8 g 1.0 mg/cm ²	<i>P</i> = 0.004 <i>P</i> = 0.004
Female volunteers	10.7 ± 3.6 g 0.6 mg/cm ²	17.2 ± 6.0 g 1.0 mg/cm ²	<i>P</i> = 0.001 <i>P</i> = 0.001
Children volunteers	8.8 ± 4.1 g 0.9 mg/cm ²	13.1 ± 5.3 g 1.4 mg/cm ²	<i>P</i> = 0.004 <i>P</i> = 0.004

application technique considerably improves the homogeneity of the sunscreen spread over the areas of the body and significantly increases the surface covered, when compared with the previous traditional way of application.

Even if the quantity applied was still insufficient (ranging from 1 mg/cm² in men and women and up to

1.4 mg/cm² in children), the actual quantity of product applied to the skin was considerably increased with the new technique. Together with the early reapplication of sunscreen that has been recently proposed as a simple strategy to increase the amount of applied sunscreen (15), this technique will help improve sunscreen use.

This study has been performed using a milk galenic preparation, because this form can be used both on the face and the body. However, the new application technique is also valid for creams (less likely to be applied on the whole body) and sprays (that are not recommended for the face as eye projections may occur). We have Woods lamp data on a limited number of subjects showing a more homogeneous application, but we did not carry out a comparative study on a cohort.

When analyzing the study results, it is surprising that the women did not achieve the same results as the men or children on the face where many of them still forgot to cover skin. A possible explanation may be that even though they were willing to follow the new application technique, the women may be used to their own personal methods when applying their cosmetics and makeup. The results on men and women for the back of the body (middle of their back) clearly demonstrate that this is a difficult area to reach with a self-application technique and that it is preferable to have the sunscreen applied by somebody else (like for the children).

We agree that the study may raise questions about potential limitations: the protocol did not plan repeated applications over a longer period. However, almost all the volunteers agreed that the new application technique was easy to follow and a vast majority declared that they were willing to continue to follow this technique in the future, which is an excellent indicator of feasibility. We believe

that this technique can be implemented on a large-scale population thanks to digital diffusion and communication. We also feel that future educational work by the dermatologists and general practitioners explaining this new technique to their patients will help improve the efficient use of sunscreens. This can be achieved with the help of dermatological societies may be during the melanoma awareness days. It might be also interesting to include the application technique in educational programs in elementary schools.

In conclusion, this new application technique enabled the sunscreen to be much more evenly applied. In addition, the skin surface area covered by the sunscreen was significantly improved. This new sunscreen application technique, recently approved by the French Association of Photodermatology, may be a useful educational tool to improve skin protection from UV radiation thus limiting photodamage.

ACKNOWLEDGEMENTS

We would like to thank Annic Lefol-Malosse and Caroline Tricaud for having developed the application technique; Dr Catherine Busi, the dermatologist who evaluated the volunteers; Ana de Lemos, Séverine Freyssinet, and Jean-Christophe Paillard for selecting the volunteers and the statistical data analysis; and Patrick Göritz for assistance with manuscript preparation.

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