

ORIGINAL ARTICLE

A preliminary study to understand the effects of mask on tinted face cosmetics

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Abstract

Background: The recent COVID-19 pandemic has generalized the use of face mask in public area, and it is now common to wear it for long hours. But face mask interfere with cosmetics, and key concerns for tinted products are staining of the mask and degradation on face. Consumers have modified beauty routine by a decrease of makeup, but are now expecting new products adapted to face mask. Little is known about the mechanisms that affect most the makeup under the face mask, so that further studies are needed to develop adequate evaluation methods and products. In this study, the color transfer on mask and makeup degradation on face are assessed through a mixed approach of consumer and instrumental evaluation.

Materials and Methods: Two tinted face products (A and B) were applied by half face on 11 Japanese women, who conducted real-life activities with a face mask during 4 hours. Panelists evaluated the stain of their face mask by visual assessment, while the makeup degradation on face was evaluated by color measurement by instrumental method.

Results: No difference was observed between the two products for lasting on face, but consumer evaluation showed a better resistance of product A for color transfer on mask.

Conclusion: The mix of instrumental and consumer evaluation is a promising way to evaluate the makeup degradation on face and color transfer on mask, which are two key factors to develop mask resistant makeup products.

KEYWORDS

color degradation, color transfer, COVID-19, face mask, foundation stain, makeup, mask staining

1 | INTRODUCTION

The use of face mask has increased worldwide due to the recent COVID-19 pandemic. To control the number of infections, the World Health Organization now recommends the use of mask, especially in closed spaces such as working offices, schools, grocery stores, or

public transportations.¹ As this pandemic is not expected to stop soon,² wearing the mask for long hours is becoming a new standard of life.

The biophysical effects of wearing a face mask are multiple. To cite a few, previous studies found that the increase of temperature and humidity under the mask affects the heart rate and exertion

when exercising,^{3,4} along with the body thermoregulation as the heat loss from face skin and respiration is decreased.⁵ The skin properties are also modified: higher skin temperature,⁶ and an increase of skin problems reported by healthcare workers from irritation and itch to aggravation of underlying conditions of seborrheic dermatitis and acne vulgaris.^{7,8} Sweating and sebum secretion, skin barrier function, TEWL, pH seem also modified in Asian volunteers.^{9,10} Lastly, in a humid climate, skin hydration increases and the friction is twice as high as in a dry condition,¹¹ so that high skin friction can be expected under the face mask.

The mask also affects the perception of beauty and makeup habits, as observed through international consumer analysis of COVID-19 impact. Makeup products can transfer to the mask, so that a soiled piece of cloth is kept on the skin for long hours. Consumers also report makeup degradation due to harsh conditions within the mask but also around the eyes as the humid air from the mask goes up. Makeup habits have been modified accordingly, with simplification of the routine with decrease of lipstick usage, switching from high covering face products to lighter finish ones to lessen color transfer, and more attention paid for eye makeup and hair, as they are the visible parts of the face. In parallel, consumers also notice higher skin troubles, increasing the need for product covering acne and pimples or blackhead. Those skin problems also led to less face makeup in an attempt to decrease the burden on a skin irritated by the mask, and an increase of interest in makeup with skin protecting and soothing properties. (Internal data: online survey on 200 Korean women, March 2020. Japan, China: Ipsos 2020 Consumer Sentiment & Behavior Tracking Study. Europe: barometer COVID impact, IPSOS, July 2019).

To summarize, mask adapted products need the following properties:

1. No color transfer to face mask, keeping it clean through the day.
2. Long lasting: cosmetics stay true through the day
3. Covering and soothing skin problems (redness, acne, spots, oily skin, and dry skin)

The lastingness of face makeup was already a key factor in product appreciation even before the COVID-19 pandemic. Past studies have described the interactions of face makeup and skin physiology. Without face mask, makeup foundation will degrade when interacting with sebum and sweat, leading to unwanted shine, patchy color effect, color modification, and decrease of covering properties.¹² In addition, skincare routine and the variability of sebum secretion among face areas leads to local degradation of foundation,¹³ and face movements added to sebum that causes the product to fall or to agglomerate into skin creases.¹⁴

With a face mask, the interacting system complicates, and makeup foundation will be exposed to a completely new set of strains, as sebum, sweat secretion are modified, but also the microclimate under the mask and cloth friction on the area of contact.

Currently, studies on makeup transfer on masks are scarce. It is known that makeup can transfer on cloth as resistant stain,¹⁵ and film-forming products have been already proposed on the market before the COVID situation to reduce this problem.¹⁶ We can suppose that the high color transfer on mask reported by consumers is linked to the fact that the fabric is pressed closely on the skin for a long time, interacting with modified makeup and skin properties compared to no-mask conditions. Face movements may also intensify the friction of the mask on skin and makeup and affect the color transfer rate.

In order to better understand the effect of mask on tinted makeup products, a mixed evaluation method of instrumental and cosmetic assessment in real-life condition is proposed to assess the resistance to mask wearing.

2 | MATERIAL AND METHODS

2.1 | Test products and panelists

Two tinted BB cream are tested: a technology with increased resistance to friction (Product A) and a market product as a bench (Product B). The products are applied by a trained experimenter, 100 mg by half face in a randomized, half-blinded way, on 11 Japanese women aged 45 to 57 (average: 52.5 ± 3.2) living in Kawasaki. All panelists are healthy, without any skin conditions or excessive sun exposure and do not take any medications. They were instructed about the objective of the study and signed an informed consent written in Japanese. The face masks are surgical mask type I, three layered, pleated (Nanaplus Ltd), made of polypropylene non-woven fabric for the filter and polyethylene on the nose fitter. Panelists can choose between normal size: 175 mm × 95 mm and smaller size: 145 mm × 95 mm so that the mask covers the cheekbone.

2.2 | Instrumental measures

In this test, the degradation of face makeup was evaluated by following the evolution of color on a region of interest situated on the cheek and covered by the mask.

Color evaluation by Chromasphere® device (Monaderm), an in-house instrument, composed of a diffuse daylight lighting device coupled to a calibrated 3CCD digital cameras.¹⁷⁻¹⁹ After the picture acquisition, color is measured on a software-selected area, set on the cheek for this study. The device measures the L,a,b, C,h, and ΔE_{94} is calculated as defined by the CIE (International Commission on Illumination). Remaining product on the face is calculated as follows: "Remaining Product % = $(\Delta E_{94} \text{After mask} - \text{Timm}) / (\Delta E_{94} \text{Timm} - \text{Tbare})$."

For illustration purposes, pictures of the face mask after 4 hours were captured by VISIA-CR® (Canfield) in polarized mode.

2.3 | Statistical analysis

Chromasphere® data were analyzed using Student *t* test for product comparison and paired one sample *t* test for time effect. Significant threshold is fixed at $P < .05$.

2.4 | Consumer evaluation of mask transfer

Test panelists complete a self-questionnaire at two hours and an interview with a professional evaluator at four hours after the start of the test, to collect information on the type of activity they carried on. Then, the panelists remove their mask and observe the color darkness and tinted area, and evaluate the side with the highest product transfer.

2.5 | Test flow

2.5.1 | T0: measure of bare skin

Test panelists wash their face with an oil cleanser followed by a foaming cleanser. Next, they apply cosmetic water and moisture lotion, and wait for 10 min to let the face dry before instrumental measurements (all products are provided by the experimenter).

2.5.2 | Timm: measure just after makeup

The tinted creams are applied on each side of the face, and the product is left 10 min for drying before instrumental measures.

2.5.3 | Real-life conditions

After Timm measures, panelists have a light meal for 30 min, then wear their face mask, and leave the testing facilities for 4 hours. They were requested to have physical activities, and they engaged into housekeeping activities ($n = 9$) and/or shopping ($n = 9$), and light outdoor activities (cycling $n = 8$ and/or walking = 7), with light or medium sweating on face ($n = 7$) to no sweating ($n = 4$). They are

allowed to wipe the sweat and sebum of the forehead, drink with hanging an ear loop on one side, but must refrain from touching the cheek and lips or removing the mask. The weather condition was around 26°C, with 50%-60% RH (Relative Humidity).

2.5.4 | T2h

After 2 hours, panelists complete a self-questionnaire and evaluate color transfer on mask.

2.5.5 | T4h

After 4 hours, they return to the testing facilities for final measurements and interview.

3 | RESULTS

3.1 | Instrumental color measurements

Table 1 gathers the statistical results of the instrumental color measures on face, and Figure 1 provides an example of the color modification observed on cheek.

3.1.1 | Time effect

In our test conditions, for both products, significant color evolution is observed after 4 hours of mask wearing, with a calculated estimation of 1/3 of product removed compared to initial amount (28% for product A, 31% for product B).

3.1.2 | Product comparison

The ΔE_{94} between makeup (Timm) and bare skin (T0) was higher in tendency for product B compared to Product A, but there was no difference of makeup lasting between products.

TABLE 1 Mean ΔE_{94} with statistical analysis of the time effect and product comparison

	Product	Mean $\Delta E_{94} \pm SD$	Time effect	Product comparison
T4h-Timm (color modification on face)	Product A	1.44 \pm 0.6	S	NS
	Product B	1.32 \pm 0.46	S	
Timm-T0 (effect of the makeup just after application)	Product A	2.5 \pm 0.76	S	Tendency ($P = .09$)
	Product B	3.04 \pm 0.66	S	
T4h-T0h (makeup effect after T4h compared to bare skin)	Product A	1.79 \pm 0.45	S	NS
	Product B	2.09 \pm 0.56	S	

Abbreviations: NS, not significant; S, significant; SD, Standard Deviation.

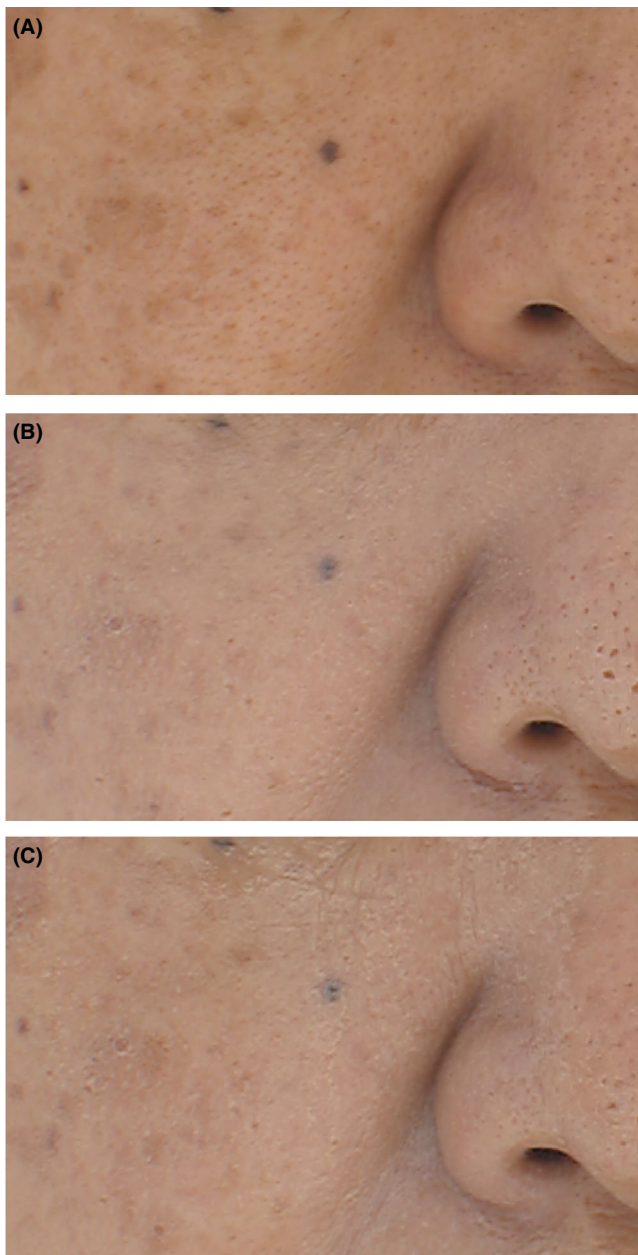


FIGURE 1 A, T0 bare skin. B, Timm just after makeup application. C, T4h after 4 hours with mask. Illustration of the makeup effect on face, on the right cheek area. Just after product application, the skin tone is lighter and coverage is homogeneous. After 4 hours with mask, makeup degradation can be observed with loss of overall coverage, patchy area and product agglomeration

3.2 | Consumer evaluation

Color transfer on face mask was assessed at both T2h and T4h. Figure 2 presents an illustration of the mask staining, and Table 2 gathers the consumer's answers. Based on those results, Product A leads to less transfer on face mask compared to product B. When asked to explain their choice, the reasons were because of the darker color of the stain ($n = 7$), because of the wider stained



FIGURE 2 Example of the staining of a face mask after 4 hours. Color transfer is observed in various areas

TABLE 2 Consumers' answers to "Which product transferred more to the mask"? Values indicate the number of models who choose the product.

	Product A	Product B	No difference
After 2 h	1	9	1
After 4 h	2	9	0

area ($n = 3$), and both darker and wider stain ($n = 1$). In order to deepen the analysis, consumers were asked for Product A whether this product would fit the "no color transfer" concept. As consumers observed staining, 7 out of 11 disagree to qualify the product as "no transfer" and 4 somehow agreed but would rather described the product as "low transfer."

The level of staining was noted medium, low, or very low for the 4 panelists who reported not sweating, while for the 7 panelists who reported sweating on the face, staining was medium, high, or very high for 5 panelists, and medium to low for two panelists. Though the panel size is small, this may give a hint that sweating may increase the product transfer on mask.

Therefore, in our study, the product with friction resistance technology brings improvement for product transfer on mask but not for product lastingness on face. Further development is needed to limit the degradation of makeup under the mask and match the mask friendly concept.

4 | DISCUSSION

The mix of instrumental and consumer evaluation in real-life conditions allowed us to follow-up two key properties of makeup resistance under face mask: makeup degradation on face and color transfer on mask. For the instrumental part, the analysis of color evolution provides statistically relevant results to follow-up the product loss even with small number of models, with repeatable, objective data. For the consumer part, the assessment of mask staining brings first insights on the transfer level and on its acceptability, to be confirmed if needed through larger consumer test.

In our study, the product A with friction resistance led to lower transfer on mask compared to bench product B, and sweating tended to increase the color transfer. Despite this difference, both showed the same makeup degradation level on the face. Therefore, transfer resistance and lastingness on face should be considered as two different properties. Resistance to friction may limit the mask staining but is not enough to improve the lastingness of makeup on the face.

The high makeup degradation may also be explained by the modification of skin and microclimate under the face mask. Indeed, previous studies showed that wearing a face mask increases sebum secretion,^{9,10} TEWL, pH,⁹ and skin temperature up 1.6 degree C on the cheeks.^{9,10} Hydration results showed increase⁹ or area dependent results.¹⁰ In addition to skin changes, the microclimate under a medical mask type 1 showed up to 4 degrees more than external temperature and close to 100% humidity (internal data, to be published soon). Those modification are likely to speed up the degradation of makeup on face under mask.

Face mask also increases the redness of the skin, lasting after mask removal.^{9,10} In future studies, this phenomenon should be taken into account when evaluating the color evolution, such as increasing the waiting time between mask removal and evaluation timing. Lastly, along with the lastingness and mask stain, the evaluation of mask friendly face makeup could also integrate a skin-soothing aspect. As the mask irritates the skin, some consumers tend to decrease the amount of face makeup to lower the burden (internal consumer data, Japan, April 2020). Therefore, providing skin benefits through makeup with adapted evaluation methodology could also support the development of mask-friendly products.

Next steps could be to complete the understanding of mask effect on makeup through other relevant evaluation method. Sensory panels could evaluate products resistance to mask with link to other sensorial aspects of the products. Another aspect to study is the test length: Here, the color evolutions were assessed after 4 hours, but consumers may wear the mask for whole daylong. The rise of connected, nomadic evaluation with AI-based automatic grading system on selfies is already used to evaluate skin conditions.²⁰⁻²³ This algorithm has been already applied with success to evaluate the sun-damage on Japanese panel based on their selfies taken at home.²⁴ The same approach could provide dynamic evolution of makeup in real life through the day, with selfies taken by consumers when they remove their mask and check their makeup. In addition, miniature captors could provide a better understanding of temperature and humidity within the mask in various conditions, but also the evolution around the eyes to explore the effect to face mask on eye makeup.

Those new methodologies would allow cosmetic companies to evaluate and develop new products adapted to face mask, with sincere consumer-centric claims. Now that the face mask is the new norm for undetermined time, mask resistance properties and claim may be valuable field for innovative products and communication.

Lastly, a holistic approach of mask effect would also include other trends emerging from the COVID-19 situation. The use of

mask as beauty attributes in Japan can give us hints for further studies. In Japan, the trend of non-medical use of face masks has emerged since 2010, to hide the face to cope with societal fear²⁵ but also as a beauty attribute.²⁶ Mask is worn to modify the perception of the size of the face, giving the impression of a smaller face as appreciated culturally,²⁷ to increase the attention on eyes area or add some mystery. Color of the mask also influence the face perception, negatively and positively.^{28,29} Those beauty effects should be considered with care, as unhealthiness perception linked to the sanitary mask may actually decrease the rating of an initially attractive face.³⁰ Therefore, the effect of mask on beauty is complex, and wearing a mask may be a constraint or a positive beauty attribute depending on the culture, trend, and individual. Lastly, the recognition of facial expression is impacted,³¹ so that it is more difficult to read feelings of a masked person. It could be interesting to study the possible benefit of makeup to counterbalance this loss of non-verbal communication.

Another new trend link to the COVID-19 is the increased of on-line discussion with tools such as Zoom® or Teams®. A study with eyetracking evaluation of models observed on monitor showed that makeup can influence the way we look at a face on a screen, especially lipstick.³² The development of screen-adapted makeup could also be a new field of communication.

In conclusion, as cosmetic industry we can answer to the COVID situation in multiple way to create new products and new claims to provide innovative proposals to consumers.

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