Review Article

Skin health response to climate change weather tailored cosmetics using artificial intelligence

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Abstract: Recently, the severity of global warming is increasing worldwide. In this study, we examined the possibility of customized cosmetics devices using artificial intelligence (AI) as a countermeasure to problems that may occur on the skin due to global warming. This includes responding flexibly to changes in consumer demand due to global warming. Additionally, in the context of global warming, the scientific community is considering human skin care and prevention methods, which we hope will provide key data for future exploration. Although this review is a descriptive review, a systematic review was conducted, and according to the PRISMA flowchart guidelines, sources such as PubMed, Medline, Scopus, ResearchGate, and Google Scholar were searched and searched for 'global warming', 'climate change', 'skin gate', 'AI', 'Customized cosmetics', 'Skin health', 'Cosmetics', 'Device', 'AI-based customized cosmetics', 'Human security', 'inner beauty'. Accordingly, a total of 1,308 documents were searched. In the final step, 65 studies were selected at the final stage. Considering the sustainability and safety of customized cosmetic devices in the AI era, further research to mitigate skin damage caused by human skin care and ultraviolet (UV) rays due to global warming and to evaluate the impact on beauty and health should reflect consumer demands. Therefore, as global warming accelerates, additional research on skin heat-resistant inner beauty materials and customized cosmetics is needed with a focus on human security in preparation for continued global warming. Accordingly, interest in AI is expected to increase further in the scientific community, nutrition, inner beauty, and cosmetics industries, and this trend is expected to continue in the future. We hope that AI based customized cosmetics devices will be used in various skin health strategies and nutritional approaches to global warming and human security.

Keywords: Global warming; skin health; artificial intelligence (AI); customized cosmetics device; human security

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Introduction

Globally, extreme heat is reported to be associated with increased mortality and morbidity. This increase in temperature due to climate change put enormous stress on humans. What is surprising is that the frequency, intensity, and duration of heat waves have also increased in most regions of the world. The rise in temperature was not limited to the summer months but was observed throughout all seasons. This situation is confirmed by the increase in both day and night temperatures across the continent. Therefore, climate change poses a serious threat to human health in the form of simultaneous increases in morbidity and mortality (1). Climate change is not only associated

with increased mortality and morbidity, but also with human skin problems due to sustainable safety. Rising temperatures due to climate change will significantly change our lives (2).

Choi *et al*. reported that the human body is greatly affected by the environment and constant heat. Human body temperature regulation is also related to environmental conditions (3). In humans, the autonomic nervous system may be activated in response to environmental disturbances in metabolism or thermal balance. Changes in human skin begin with cutaneous vasodilatation. This means that the skin that occupies the surface of the human body becomes irritated. It occupies the largest part and emphasizes its importance. Abnormal temperatures and the high heat of global warming can increase the rate of dry skin. It is primarily convective and radiative and may experience evaporative transfer. Additionally, various reactions are determined depending on the characteristics of the skin and environment (4). The most important thing in this situation is that climate change-related factors are affecting the skin's ability to maintain homeostasis. It is reported that various skin diseases suffered by humans are triggered at this point mainly caused by strong exposure to ultraviolet (UV) rays, such as depletion of Earth's stratospheric ozone. Depending on these situations, your skin may have serious problems. For example, it can be said that the risk of melanoma and keratinocyte carcinoma increases. This is also reported to be related to the increase in air pollution on Earth. Skin diseases related to this include atopic dermatitis, psoriasis, melasma, and photoaging (4,5).

Climate variability and change can expose humans to suboptimal temperatures and extreme weather conditions. Additionally, the scope and transmission of infectious diseases increases. As a result, it is already having a negative impact on the health of tens of millions of Africans (1,6). The diverse impacts of climate change require responses appropriate to the scale. Adapting to the impacts of climate change is particularly difficult in poor areas. Additionally, it will be difficult to quickly respond and mitigate human areas (7). Human security is a complementary concept to the existing state-centered security concept, and is a concept secures everyone's safety, abundance, and pursuit of happiness. Human security is a concept that has begun to receive attention due to the occurrence of various transnational problems that cannot be explained by traditional security concepts. In relation to the climate crisis, human security is redefined as "conditions created when the core elements essential to human life are protected and when people have the freedom and capacity to live with dignity" (8-10).

In addition, artificial intelligence (AI), which is rapidly developing due to the recent 4th Industrial Revolution, is a field of computer science that artificially implements human learning, reasoning, and perception abilities. This is a field of computer science that can be applied to human daily life to create a new world. Due to the development of AI, we can also see the transformation of various customized devices that can help people achieve well-being and beauty in their lives (11). Currently, AI technology is adopted by several pharmaceutical and biotechnology companies across the world in the medical AI market. AI is being increasingly used for health today. In response to this situation, systems are being utilized to deliver functional materials in the cosmetics and health food customized industries. This is being done with a focus on personal management (12). A customized cosmetics device is a device that provides customized cosmetics by considering the consumer's skin condition, preferences, or other personal factors. Unlike conventional cosmetics, these devices are manufactured considering the characteristics of individual consumers and utilize various technologies and data to create customized products (13). Recently, some research provides individual skin measurement and analysis based on AI technology. This is a customized beauty service platform tailored to everyone's skin. For these uses, we use daily charts to store and manage your personal data. It utilizes customized cosmetics curation and O2O (Online to Offline) beauty management. Personalized services are gradually evolving. We provide knowledge from skin experts combined with AI technology. Lee *et al.* examine the possibility of dermatological use of skin data. It is about the possibility of applying AI to improve skin health and telemedicine (13). In addition, due to technological advancements in AI technology, various studies are being conducted in the fields of dermatology and cosmetics. AI is being used in various industries such as dermatology, skin research, cosmetics, and personalized services (14,15). At the 2020 Consumer Electronics Show held in Las Vegas, a home appliance that creates customized cosmetics on demand was unveiled. It has been revealed that the global beauty industry is competing to develop beauty devices. A system was created that allows you to check with simple photos by considering variables such as the influence of the season, temperature, humidity, and menstrual cycle. Through this system, IoT-enabled machines are integrated into customized moisturizer combinations (13). As aging

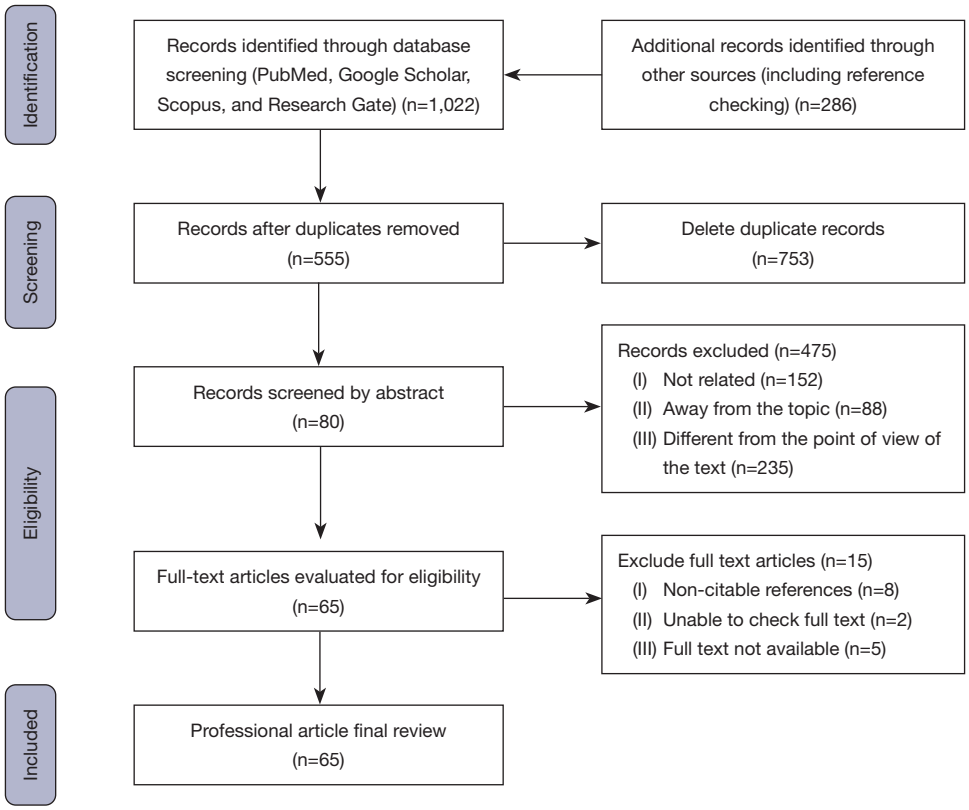

Figure 1 PRISMA flow diagram.

continues worldwide, we would like to quantitatively evaluate facial skin aging. There have also been attempts to use AI models for this. However, the correlation between AI models and human perception of skin aging has not yet been established (16,17).

Therefore, this study examined the possibility of customized cosmetic devices using AI as a response to problems that may occur on the skin due to global warming. Additionally, in the context of global warming, the scientific community is considering human skin care and prevention methods, which it is hoped will provide key data for future exploration.

Materials and methods

Although this review is a descriptive review, a systematic review was conducted by individually setting related keywords according to the PRISMA flowchart guidelines. The search method is as follows: PubMed, Scopus, ResearchGate, Google Scholar for 'global warming', 'climate change', 'skin gate', 'AI', 'Customized cosmetics', 'skin health', 'Cosmetics', 'Device', 'AI-based customized cosmetics', 'Human security'. Accordingly, a total of 1,308 documents were searched. In the final step, 65 documents were selected and included in the paper, denoted as PRISMA in *Figure 1*. *Figure 1* systematically shows the flow diagram of the process of finding and selecting studies for in this systematic review. A model diagram of the studies can also be found in *Figure 2* (18).

Search strategy

This study is a comprehensive literature review with additional articles from the years 2003 to 2023 in the following databases: PubMed, Medline, Scopus, ResearchGate, and Google Scholar. The search algorithm is as follows: [('Global warming' OR 'Climate change' OR 'skin problems' OR 'AI' OR 'Customized cosmetics' OR 'Device' OR 'Healthy skin' OR 'Human security' OR 'Cosmetics' OR 'Customized cosmetics' OR 'AI-based customized cosmetics') AND (skin problems due to global warming)]. To ensure the relevance of the study, a search

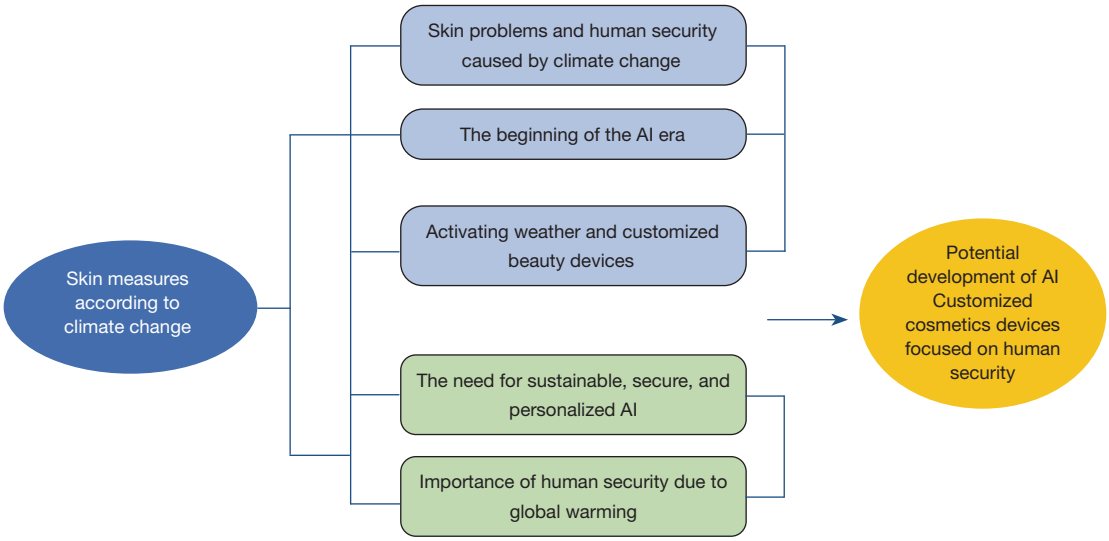

Figure 2 Research model diagram. AI, artificial intelligence.

was conducted using these terms.

Study selection

Studies were considered eligible according to the following process: first, it was con-firmed that the study contained quantitative data; second, the title was first checked and reviewed; third, studies with only abstracts or whose contents could not be confirmed were excluded. In addition, after reviewing the abstracts of the papers, all studies were evaluated according to the inclusion criteria. This iteration was performed to ensure quality assessment was clear. The tool identified 65 publications, but not all items were suitable for all studies. Only relevant items were used, as shown below. Of the 1,308 papers retrieved, 350 were irrelevant studies, 88 were off-topic, and 152 were different from the main text. We removed 235 and recorded this. In addition, an additional 15 references were removed, including uncitable references (n=8), unavailable full text (n=2), and unavailable full text (n=5). A total of 65 final items were included.

Data extraction and management

A standardized data extraction format was utilized to extract data using the following, e.g., skin problems caused by global warming and abnormal temperatures and customized cosmetic devices in the AI era. Outcome measurements were also included. PRISMA were also conducted to standardize data collection to clarify the extraction format. In addition, a method of reexamining the extracted data several times was used.

Characteristics of the included studies

Abnormal changes due to global warming are summarized in *Table 1*. This suggests that the world is experiencing major changes due to rapidly changing global warming and its related problems. Additionally, information on skin problems caused by climate change is summarized in *Table 2*. This suggests skin care problems caused by global warming (*Figure 3*). This represents the AI area of sustainable human security. The opening of the AI era is summarized in activating weather and customized beauty devices in *Table 3*. This indicates infinite development potential for customized cosmetics devices using AI in the future.

Results

Skin problems and human security caused by climate change

The continued increase in Earth's population and human activities has had a profound impact on the Earth's environment. This is a problem caused by human activities. Natural disasters caused by climate change pose a direct threat to human security. Global warming and increased

Table 1 Abnormal changes and human security due to global warming

Author and references	Journal name	Title	Summary	Discussion
Allen *et al.* [2014] (19)	*Oxford*	In towards a better global economy: policy implications for citizens worldwide in the 21st century	Increase in global population and human activity	Over the past 100 years, the world's population has quadrupled, and economic production has increased approximately 20-fold, leading to a significant increase in demand for natural resources
Fetting [2020] (20)	*ESDN Report*	The European Green Deal	Solution to environmental pollution	The development of a more circular economy, biodiversity, and a non-toxic environment; and sustainable and smart mobility
Eastwood [2021] (21)	*QJM*	Global warming and the laws of nature	Natural disasters caused by climate change	Concerns about our planet's environment due to global warming are real. Strategies to control these unwelcome developments are radical and will bring profound changes to our lifestyles
Odonkor and Sallar [2020] (22)	*Biomed Res Int*	Global warming, heat-related illnesses, and the dermatologist	Increase in GW and GHG emissions	Global warming is a serious threat to human existence. The relatively high level of recent global warming poses greater risks to human health, both directly and indirectly

GW, global warming; GHG, greenhouse gas.

Table 2 Skin problems due to climate change

References	Global warming problems	Global warming skin problems	Relationship	Symptom
(2)	Temperature rise	Atopic dermatitis	Symptoms may worsen as temperatures rise and are likely to worsen during seasonal changes when there is a large temperature difference between day and night	Temperature and humidity are lower than in summer, which increases skin moisture loss and damages the skin barrier
		Acne	It is a skin condition that occurs when hair follicles become clogged with oil and dead skin cells	It mainly appears on the face, neck, back, and chest where sebum is actively secreted, and blackheads, whiteheads, freckles, and cysts appear
		Psoriasis	Symptoms may worsen as temperature rises. It is a chronic skin disease that causes the skin to become very dry, itchy, and covered in red spots and scales	As temperatures rise, skin becomes dry and moisture evaporates faster, which can worsen psoriasis symptoms
(2,23)	Natural disasters caused by abnormal temperatures	Acute skin infection	Disasters cause great damage, ranging from casualties including death to livestock deaths and loss of facilities and property	Skin infections are one of the casualties of natural disasters. For example, water contamination due to flooding increases the risk of skin infections. Additionally, if buildings collapse during an earthquake, there is an increased risk of injury, which increases the risk of infection
		Inflammatory skin disease	Inflammatory skin disease is one of the damages caused by natural disasters. Symptoms of skin infections caused by natural disasters vary. For example, water contamination due to flooding increases the risk of skin infections. When buildings collapse during an earthquake, there is an increased risk of injury, which increases the risk of infection	The skin becomes dry, red, and swollen. A rash appears on the skin, accompanied by itching

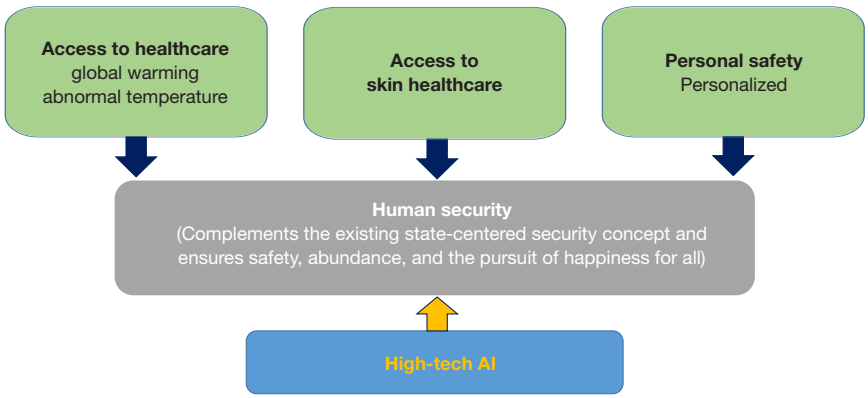

Figure 3 Areas of sustainable human security and AI. AI, artificial intelligence.

Table 3 Activating weather and customized beauty devices

References	Division	Company name	Characteristic	Detail
(24)	Subscription cosmetics service	*Tone28*	After conducting an offline skin diagnosis with customers, we use climate change big data to create a model to predict monthly skin condition and deliver cosmetics	This cosmetic product is suitable for the external environment because the skin is affected by approximately 70% of environmental factors
(25)	Custom cosmetic devices	*L'Oréal*	In addition to cosmetics, a device that makes cosmetics according to the weather	It is a device that integrates everything from personal skin analysis, environmental evaluation such as weather and temperature, and cosmetics preparation technology that reflects product preferences into one device. When a user makes a request through a mobile phone app, AI analyzes skin condition, air quality, pollution level, trends, etc. and manufactures a customized disposable skin lotion

AI, artificial intelligence.

greenhouse gas emissions are all serious interrelated problems disguised as climate change around the world. This pollution and degradation continue (19,20), Recently, in the European Union, a movement was launched in the early 1990s to mitigate the impact of human activities on the environment. With this mobilization, measures began to be proposed (26). Various strategies are needed to lower global temperatures. The latest climate change strategy later appeared in the Kyoto Protocol. This is the Emissions Trading System (27). Established through the Paris Climate Agreement. As such, efforts to suppress climate change are spreading worldwide. This became clearer when the European Commission announced the Green Deal in December 2019 (28). The most pressing issue around the world is probably concern about the global environment due to global warming. This global warming is related to greenhouse gases caused by various activities necessary for our lives. This situation is having a tremendous impact on the lives of people around the world. Accordingly, there is also great fear about what changes will occur in the future. However, the actual cause of this problem may never be solved, and it is highly likely that it will continue to be an un-solved problem. Changes in human perception will require consideration of the environment and the Earth. Accordingly, there is an emphasis on safer products and sustainable human security (21,29). This research is supported by a recent study that assessed public knowledge and potential health impacts of global warming. Adults (N=1,130) were surveyed from November 1, 2018, to February 28, 2019. Among them, about 84.4% of

respondents understood the meaning of global warming. The causes of global warming recognized by respondents are as follows. Natural processes, deforestation, God's will, fossil fuel combustion and CO_2 followed in that order. Additionally, 83.4% of respondents confirmed the opinion that global warming affects human health. Therefore, awareness of global warming is being strengthened worldwide (22). Rising temperatures due to global warming cause various skin problems. Rising temperatures can worsen the symptoms of atopic dermatitis. There are skin diseases that are particularly susceptible to worsening during the change of seasons when the temperature difference between day and night becomes severe. This is atopic dermatitis. This is because the temperature and humidity are lower than in summer, which increases skin moisture loss and damages the skin barrier. Especially when the weather is cold, excessive indoor heating or bathing with hot water increases moisture loss from the skin, making the symptoms of atopic dermatitis worse (22). The second is acne vulgaris. Acne vulgaris is one of the common types of acne and is a skin disease that occurs when hair follicles are clogged with oil and dead skin cells. It mainly appears on the face, neck, back, and chest where sebum is secreted actively, and blackheads, whiteheads, comedowns, and cysts appear. Rising temperatures can worsen psoriasis. Psoriasis is a chronic skin disease that causes the skin to become very dry, itchy, and covered with red spots and scales. As the temperature rises, the skin becomes dry and moisture evaporates faster, which can worsen psoriasis symptoms. This rapid rise in temperature can cause various diseases and disturbance of the skin microbiome. High temperatures can also lead to worsening of skin diseases and skin cancer. It also affects abnormal weather phenomena caused by climate change. It is also associated with rapid damage to the skin, acute skin infections, and acute exacerbations of inflammatory skin diseases (23,30,31).

The beginning of the AI era

Medical AI, which has recently been expanding, is the fastest growing technology field within AI. With the development of AI programs, disease diagnosis and treatment protocol development can be carried out. Additionally, drug development, personalized medicine, and clinical decision support systems are all accomplished at once. Data is obtained and customized patient monitoring is performed. AI is already being applied and utilized in many areas of the medical field. Another major growth factor for the current medical AI market is research on potential applications of Large Language Model in healthcare education, health research, and practice. Recently, AI-based language models have been showing impressive performance. Furthermore, additional research is continuing to determine whether it can be used in real-life scenarios, especially in fields such as medicine that require high-level complex thinking. There is still uncertainty about how well it will perform, but this will quickly ease due to the rapid development of the Fourth Industrial Revolution (32-41). It has been used in modern medicine for the past 20 years to help clinicians define diagnoses. It also identifies prognostic predictions for specific conditions. We also use AI for many of the tasks that make up our treatment solutions. This has become a trend on social media and news platforms in a very short period: guiding a model to solve a task by applying minimal human feedback. A public document signed by hundreds of AI experts, scientists, and entrepreneurs in March 2023 states: it was about pausing further testing and development of AI models like ChatGPT. Despite these problems, research on the use of ChatGPT and discussions on various uses are continuing around the world and are expected to spread further in the future (42-44).

Activating weather and customized beauty devices

AI technology is also being used in the cosmetics industry. Customized cosmetics recommendation services using AI technology are emerging, and through this, the 'hyper-personalized customized beauty market' is growing, where an individual's skin or hair condition is checked, and appropriate cosmetics or beauty products are recommended (45). Everyday beauty products, from cosmetics to beauty devices and survey apps, are evolving into customized beauty services through AI (46). The level of personalization is optimized over time as the system collects more data about customers' skin and personal preferences. It is a beauty device called 'Persona Skin' that allows you to manufacture customized cosmetics at home (47). Using AI technology, it analyzes an individual's skin concerns and environmental factors to suggest cosmetic prescriptions and creates customized facial serum treatments based on this. Four companies in the beauty tech field that Jeju Techno Park supported through its big data-based customized cosmetics platform construction project are also conducting research on beauty tech products that combine big data and AI technology. Linkerverse's nail diagnosis device 'Healthy Bus', Aram Huvis' AI scalp and skin diagnosis device 'AI Scalp Grader',

A&D Partners' skin image acquisition device 'MediScope', and Chowis Company's smartphone-connected skin diagnosis device 'My'. Linkerverse's Healthy Bus, including 'skin F.A.I.N', is an innovative healthcare service that predicts an individual's health status by extracting disease similarities and nutritional deficiency symptoms through nail imaging devices and deep learning nail AI algorithms. Aram Huvis' AI Scalp Grader is a system that uses AI learned from over 100,000 pieces of scalp data to classify individual scalp conditions into 10 types and prescribe individual scalp care solution products according to 3 levels of severity (24,25). *Tone28* is a subscription cosmetics service that delivers 'application items' optimized for individual skin. After performing an offline skin diagnosis with the customer, we use climate change big data to create a model that predicts monthly skin condition and deliver cosmetics. Since the skin is affected by about 70% of environmental factors, the idea was to apply cosmetics suitable for the external environment. In addition to cosmetics, devices that make cosmetics according to the weather have also appeared. *L'Oréal*, a global cosmetics company, has developed Perso, an AI based customized cosmetics device that allows individuals to create cosmetics tailored to their skin. This is a device that combines everything from personal skin analysis, environmental evaluation such as weather and temperature, and cosmetic preparation technology that reflects product preferences into one device. When a user submits a request through a mobile phone app, AI analyzes skin condition, air quality, pollution, trends, etc. to manufacture a one-time customized skin lotion. It is said that foundation, lipstick, etc. can be manufactured in the same way (13,24,25). Activating weather and customized beauty devices are summarized in *Table 3*.

Discussion

Main findings

This systematic review is the first report to highlight the potential use of AI enabled personalized cosmetic devices as a response to potential skin problems caused by global warming. Considering the sustainable safety and consequent need for abnormal changes on Earth and human skin problems resulting from the acceleration of global warming, additional research on customized cosmetic devices suitable for the future continuous AI era is needed. This topic will attract increasing interest from academia and the cosmetics industry in the coming years, and given its importance to human security, this trend is likely to continue in the future.

What is the relationship between global warming and human security?

Global warming is a problem caused by human activities. Natural disasters caused by climate change pose a direct threat to human security. Floods, droughts, heat waves, and rising sea levels caused by climate change threaten human life and safety. Additionally, food shortages, water shortages, and conflicts caused by climate change have a significant impact on human security (6-10). Therefore, the problem of global warming is a serious threat to human security. Accordingly, additional research and responsible awareness of human security will be needed (48-52). The relationship between global warming and human security can be confirmed in *Figure 3*.

Why use AI customized cosmetics devices to combat global warming and skin health?

We provide the knowledge of beauty experts combined with AI technology. We provide a variety of beauty services including skin, hair, health, and makeup. We also focus on providing dating services that encourage user centered service and personalization. In collaboration with dermatologists, we explore the potential dermatologic use of previously collected patient skin data (11-13). The most important thing is that AI technology will check abnormal temperatures and reflect temperature, humidity, UV exposure, fine dust, etc. In addition, by incorporating individual environmental factors, their lifestyle factors such as sleep quality and quantity, water intake, and stress must be found, reflected, and analyzed (21-25,30,31). Therefore, to reflect continuous safety considering human security, it will be necessary to calculate and quantify comprehensive factors, including recent global warming and abnormal temperatures, climate impacts, and DNA diagnosis. To improve health and beauty by providing customized inner beauty products and customized cosmetics, which are the optimal customized solutions, it will be necessary to utilize devices that connect the construction of innovative services using customized digital technology incorporating AI (51-59). As such, a variety of approaches and technologies can be utilized to conduct AI-based personalized cosmetics research. The first is skin analysis and diagnosis. This uses a smartphone camera or store machine to diagnose the consumer's skin condition. It analyzes items related to skin health such as dark circles, wrinkles, and elasticity, and selects an appropriate product from among the numerous cosmetics in big data. We recommend products. Second,

it is a data-based recommendation system. We develop customized cosmetics manufactured to suit the consumer's skin type and individual needs. By analyzing user reviews, search patterns, etc., we recommend cosmetics by age, skin type & concern, and category. It provides ranking information and matches it with user skin characteristic data to provide various personalized recommendation services (3,13). Third, is the use of the technology acceptance model. In a study exploring the moderating effect of self-efficacy on basic cosmetics consumption, the technology acceptance model was used. Analyze consumers' intention to accept customized cosmetics by considering the degree to which they subjectively feel useful, subjective norms, and ease of use (60-62). By combining these methods, it will be possible to conduct AI-based customized cosmetics research. However, continuous research and improvement are necessary to ensure consumer satisfaction and efficient product development (63).

Are discussions taking place on solving skin problems in connection with AI-based customized cosmetics?

AI has incredible potential to improve dermatology treatments and deliver products tailored to consumers' needs. Research is currently underway on dermatological AI-based software as medical devices (SaMD) to ensure that end users (healthcare professionals and the public) of AI-based SaMD can appropriately use these devices (64). Additionally, AI technology is gaining popularity in various industries such as skin research, cosmetics, and personalized services. An AI-based system is being developed to quantitatively evaluate and diagnose skin aging through facial images (14). *Amore Pacific* developed Dr.AMORE® v1.2, an AI facial aging diagnosis system. The system utilizes **SSR-Net (Soft Stagewise Regression Network)** as its backbone and was trained by collecting 11,000 facial images from Korean volunteers aged 19 to 79. The system incorporates a de-identification process on facial structure to predict age considering skin condition. Areas that are difficult to intuitively recognize as skin, such as hair and eyebrows, were excluded from learning. Additionally, the robustness of the system was increased by utilizing face location information along with face images (14,15,64,65). The system was evaluated for accuracy by comparing it with the results of clinical experts. Efficiency was verified by evaluating the correlation between facial aging recognition and system prediction results. These technologies are expected to be of great help in skin care and cosmetics selection in the future (16,17).

What is already known about this topic, and what does this study add?

In the previous review, several studies were conducted linking green industries with skin problems caused by global warming and the resulting countermeasures. In addition, research has been conducted on global warming and skin heat resistance, and much research has been conducted on global warming and skin problems. However, there is no prior research on the development of AI customized cosmetics devices utilizing the 4th Industrial Revolution based on human security that can promote sustainability even amid global warmings. To date, individual research has been conducted on global warming, skin problems, and the applicability of AI, but there has been no research examining the applicability of this in conjunction with human security and the environment. Initial evidence for this effect was recently published. Therefore, the AI skin health diagnosis service is conducted using a skin diagnosis deep learning algorithm. It is possible to diagnose the user's wrinkles, redness, elasticity, damage, and pigmentation. By recommending optimized solutions according to abnormal temperatures, we will provide a differentiated experience to each human being.

Limitations of this study

This study systematically emphasizes the potential of customized cosmetic devices using AI as a response to problems that may occur on the skin due to global warming, but it has several limitations. Systematic reviews are continuously tested and conducted multiple times to obtain consistent and relevant scientific papers containing key findings. However, despite this structured analysis, we recognize that there are some limitations. First, the limitation is that the number of articles was small and there was a lack of evidence to support it. This is reflected in the fact that no research has yet been published on personalized cosmetic devices using AI. Second, global warming and human security have not been identified as topics in scientific publications and require further research. Third, despite using PRISMA for systematic review, it was difficult to connect due to the lack of research on skin problems and human security caused by global warming and AI customized cosmetics devices. In addition, there is a lack of research on the applicability of AI customized cosmetics

devices and climate and humidity. Therefore, additional research on human security that can be used amidst global warming should continue to be conducted considering the relationship between global warming and skin that can respond to abnormal global temperatures.

Conclusions

The purpose of this paper is to examine the possibility of customized cosmetic devices using AI as a response to problems that may occur on the skin due to global warming. This includes responding flexibly to changes in consumer demand due to global warming. Additionally, in the context of global warming, the scientific community is considering human skin care and prevention methods, which it is hoped will provide key data for future exploration. Therefore, as global warming accelerates, additional research is needed on heat-resistant skin inner beauty materials and customized cosmetics that focus on human security in preparation for continued global warming. Accordingly, interest in AI is expected to increase further in the scientific community, nutrition, inner beauty, and cosmetics industries, and this trend is expected to continue in the future. However, there is still a lack of discussion on global warming and AI-based customized cosmetics, and there is a lack of reference literature on this. Accordingly, we expect that AI-based customized beauty devices will be used in various skin health strategies and nutritional approaches to combat global warming and human security, and that additional research will continue.

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Footnote

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Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://jmai.amegroups.com/article/view/10.21037/jmai-24-71/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Bhatta M, Field E, Cass M, et al. Examining the Heat Health Burden in Australia: A Rapid Review. Climate 2023;11:246.
2. Lee J, Kwon KH. Sustainable Countermeasures for Skin Health Improvement for Green Consumers: The Utilization of Hsian-Tsao during Global Warming. Sustainability 2023;15:14619.
3. Choi B, Schnall PL, Yang H, et al. Sedentary work, low physical job demand, and obesity in US workers. Am J Ind Med 2010;53:1088-101.
4. Goldstein DS. Stress and the "extended" autonomic system. Auton Neurosci 2021;236:102889.
5. Belzer A, Parker ER. Climate Change, Skin Health, and Dermatologic Disease: A Guide for the Dermatologist. Am J Clin Dermatol 2023;24:577-93.
6. Allarané N, Atchadé AJ, Azagoun VVA, et al. Assessment of Climate Risks, Vulnerability of Urban Health Systems, and Individual Adaptation Strategies in the City of N'Djaména (Chad). Climate 2024;12:5. https://doi.org/10.3390/cli12010005
7. Amiraslani F, Dragovich D. A Social Dimension of Adaptation and Mitigation of Climate Change: Empowering Local Rural Communities to Confront Extreme Poverty. Climate 2023;11:240.
8. Ihinegbu C, Mönnich S, Akukwe T. Scientific Evidence for the Effectiveness of Mangrove Forests in Reducing Floods and Associated Hazards in Coastal Areas. Climate 2023;11:79.
9. Wolf T, Lyne K, Martinez GS, et al. The Health Effects of Climate Change in the WHO European Region. Climate 2015;3:901-36.
10. Gahi NZ, Dongo K, Badolo M. Using a New Approach to Design Innovative Tools for Monitoring and Evalu-ating Water Policy of Burkina Faso in Response to Climate

Risks. Climate 2015;3:1057-78.
11. Ge J, Lai JC. Artificial intelligence-based text generators in hepatology: ChatGPT is just the beginning. Hepatol Commun 2023;7:e0097.
12. Alhasan K, Al-Tawfiq J, Aljamaan F, et al. Mitigating the Burden of Severe Pe-diatric Respiratory Viruses in the Post-COVID-19 Era: ChatGPT Insights and Recommendations. Cureus 2023;15:e36263.
13. Lee J, Kwon KH. Recognition and the development potential of mobile shopping of customized cosmetic on untact coronavirus disease 2019 period: Focused on 40's to 60's women in Seoul, Republic of Korea. J Cosmet Dermatol 2021;20:1975-91.
14. Flament F, Jiang R, Houghton J, et al. Accuracy and clinical relevance of an automated, algorithm-based analysis of facial signs from selfie images of women in the United States of various ages, ancestries and phototypes: A cross-sectional observational study. J Eur Acad Dermatol Venereol 2023;37:176-83.
15. Flament F, Zhang Y, Yu Z, et al. Developing an Artificial Intelligence (A.I)-based descriptor of facial appearance that fits with the assessments of makeup experts. Skin Res Technol 2021;27:1081-91.
16. Li Z, Koban KC, Schenck TL, et al. Artificial Intelligence in Dermatology Image Analysis: Current Developments and Future Trends. J Clin Med 2022;11:6826.
17. Flament F, Maudet A, Ye C, et al. Comparing the self-perceived effects of a facial anti-aging product to those automatically detected from selfie images of Chinese women of different ages and cities. Skin Res Technol 2021;27:880-90.
18. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
19. Allen F, Behrman JR, Birdsall N, et al. Towards a Better Global Economy: Policy Implications for Citizens Worldwide in the 21st Century. Oxford: University of Oxford; 2014:381.
20. Fetting C. The European Green Deal, ESDN Report; ESDN Office: Vienna, Austria, 2020. Available online: https://scholar.google.com/scholar_lookup?title=The+European+Green+Deal,+ESDN+Report&author=Fetting,+C.&publication_year=2020
21. Eastwood MA. Global warming and the laws of nature. QJM 2021;114:227-8.
22. Odonkor ST, Sallar AM. An Assessment of Public Knowledge and Potential Health Impacts of Global Warming in Ghana. Biomed Res Int 2020;2020:7804692.
23. Lee J, Kwon KH. Why is generation MZ passionate about good consumption of K-cosmetics amid the COVID-19 pandemic? J Cosmet Dermatol 2022;21:3208-18.
24. be-myb. #37 What happens when a brand meets the weather?. be-myb 2023. Available online: https://bemyb.kr/contents/?q=YToxOntzOjEyOiJrZXl3b3JkX3R5cGUiO3M6MzoiYWxsIjt9&bmode=view&idx=5618132&t=board&category=5PQxf5lw6n
25. Daewook S. Innovative beauty tech future... 'Cosmetics made at home'.CMN.2023.01.11. Available online: https://www.cmn.co.kr/mobile/sub_view.asp?news_idx=40820
26. Chen J, Chepeliev M, Garcia-Macia D, et al. EU Climate Mitigation Policy; International Monetary Fund: Washington, DC, USA, 2020; ISBN 9781513552569. Available online: https://scholar.google.com/scholar_lookup?title=EU+Climate+Mitigation+Policy&author=Chen,+J.&author=Chepeliev,+M.&author=Garcia-Marcia,+D.&author=Iakova,+D.&author=Roaf,+J.&author=Shabunina,+A.&author=van+der+Mensbrugghe,+D.&author=Wingender,+P.&publication_year=2020
27. Bohringer C. The Kyoto Protocol: A Review and Perspectives. Oxf. Rev. Econ. Policy 2003; 19: 451–466.
28. European Commission. The European Green Deal; European Commission: Luxembourg 2019. Available online: https://scholar.google.com/scholar_lookup?title=The+European+Green+Deal&author=European+Commission&publication_year=2019
29. Han JA, Kwon KH. Purchase behavior according to the development of sustainable pistachio (Pistacia vera L.) rice cake: For Korean consumers. Sustainability 2023;15:7608.
30. So B, Kwon KH. Nutritional approaches of the changing consumer after the pandemic: Sustainable potential of phytoene and phytofluene for photoprotection and skin health. Sustainability 2023;15:4416.
31. Belzer A, Parker ER. Climate Change, Skin Health, and Dermatologic Disease: A Guide for the Dermatologist. Am J Clin Dermatol 2023;24:577-93.
32. Cascella M, Montomoli J, Bellini V, et al. Evaluating the Feasibility of ChatGPT in Healthcare: An Analysis of Multiple Clinical and Research Scenarios. J Med Syst 2023;47:33.
33. Eggmann F, Weiger R, Zitzmann NU, et al. Implications of large language models such as ChatGPT for dental medicine. J Esthet Restor Dent 2023;35:1098-102.
34. Eggmann F, Blatz MB. ChatGPT: Chances and Challenges for Dentistry. Compend Contin Educ Dent 2023;44:220-4.
35. Rusandi MA, Ahman, Saripah I, et al. No worries with

ChatGPT: building bridges between artificial intelligence and education with critical thinking soft skills. J Public Health (Oxf) 2023;45:e602-3.
36. Gordijn B, Have HT. ChatGPT: evolution or revolution? Med Health Care Philos 2023;26:1-2.
37. Lecler A, Duron L, Soyer P. Revolutionizing radiology with GPT-based models: Current applications, future possibilities and limitations of ChatGPT. Diagn Interv Imaging 2023;104:269-74.
38. Fatani B. ChatGPT for Future Medical and Dental Research. Cureus 2023;15:e37285.
39. Sifat RI. ChatGPT and the Future of Health Policy Analysis: Potential and Pitfalls of Using ChatGPT in Policymaking. Ann Biomed Eng 2023;51:1357-9.
40. Temsah O, Khan SA, Chaiah Y, et al. Overview of Early ChatGPT's Presence in Medical Literature: Insights From a Hy-brid Literature Review by ChatGPT and Human Experts. Cureus 2023;15:e37281.
41. Strong E, DiGiammarino A, Weng Y, et al. Performance of ChatGPT on free-response, clinical reasoning exams. medRxiv 2023;29:2023.03.24.23287731.
42. Májovský M, Černý M, Kasal M, et al. Artificial Intelligence Can Generate Fraudulent but Authentic-Looking Scientific Medical Articles: Pandora's Box Has Been Opened. J Med Internet Res 2023;25:e46924.
43. Keiper MC. ChatGPT in practice: Increasing event planning efficiency through artificial intelligence. 2023;33:100454. doi: 10.1016/j.jhlste.2023.100454.
44. Dave T, Athaluri SA, Singh S, et al. ChatGPT in medicine: an overview of its applications, advantages, limitations, fu-ture prospects, and ethical considerations. Front Artif Intell 2023;6:1169595.
45. Lee J, Kwon KH. The significant transformation of life into health and beauty in metaverse era. J Cosmet Dermatol 2022;21:6575-83.
46. Lee J, Kwon KH. Good ingredients from foods to vegan cosmetics after COVID-19 pandemic. J Cosmet Dermatol 2022;21:3190-9.
47. Lee J, Kwon KH. The significant value of sustainable cosmetics fragrance in the spotlight after COVID-19. J Cosmet Dermatol 2022;21:6540-8.
48. Zhao X, Li H, Cai Q, et al. Managing Extreme Rainfall and Flooding Events: A Case Study of the 20 July 2021 Zhengzhou Flood in China. Climate 2023;11:228.
49. Gushchina D, Tarasova M, Satoshina E, et al. The Response of Daily Carbon Dioxide and Water Vapor Fluxes to Temperature and Precipitation Extremes in Temperate and Boreal Forests. Climate 2023;11:206.
50. Soon W, Connolly R, Akasofu SI, et al. The Detection and Attribution of Northern Hemisphere Land Surface Warming (1850–2018) in Terms of Human and Natural Factors: Challenges of Inadequate Data. Climate 2023;11:179.
51. Overland JE. Super Climate Events. Climate 2023;11:169.
52. Curado LFA, Paulo SR, de Paulo IJC, et al. Trends and Patterns of Daily Maximum, Mini-mum and Mean Temperature in Brazil from 2000 to 2020. Climate 2023;11:168.
53. Mfitumukiza D, Mwesigwa GY, Kayendeke EJ, et al. Local Context Capacity Building Needs for Climate Change Adaptation among Smallholder Farmers in Uganda: Policy and Practice Implications. Climate 2024;12:10.
54. Kyaw Y, Nguyen TPL, Winijkul E, et al. The Effect of Climate Variability on Cultivated Crops' Yield and Farm Income in Chiang Mai Province, Thailand. Climate 2023;11:204.
55. Grigorieva E, Livenets A, Stelmakh E. Adaptation of Agriculture to Climate Change: A Scoping Review. Climate 2023;11:202.
56. Varentsov M, Krinitskiy M, Stepanenko V. Machine Learning for Simulation of Urban Heat Island Dynamics Based on Large-Scale Meteorological Conditions. Climate 2023;11:200.
57. Tsuji M. Survey on Fungi in Antarctica and High Arctic Regions, and Their Impact on Climate Change. Climate 2023;11:195.
58. Zhang C, Xiao C, Li S, et al. Analysis of the Composite Risk Grade for Multi Extreme Climate Events in China in Recent 60 Years. Climate 2023;11:191.
59. Innocenti M, Perilli A, Santarelli G, et al. How Does Climate Change Worry Influence the Relationship between Climate Change Anxiety and Eco-Paralysis? A Moderation Study. Climate 2023;11:190.
60. Sutterby E, Thurgood P, Baratchi S, et al. Microfluidic Skin-on-a-Chip Models: Toward Biomimetic Artificial Skin. Small 2020;16:e2002515.
61. Zoio P, Oliva A. Skin-on-a-Chip Technology: Microengineering Physiologically Relevant In Vitro Skin Models. Pharmaceutics 2022;14:682.
62. Abaci HE, Guo Z, Doucet Y, et al. Next generation human skin constructs as advanced tools for drug development. Exp Biol Med (Maywood) 2017;242:1657-68.
63. Ingvar Å, Oloruntoba A, Sashindranath M, et al. Minimum labelling requirements for dermatology artificial intelligence-based Software as Medical Device (SaMD): A consensus statement. Australas J Dermatol 2024;65:e21-9.

64. Daneshjou R, Barata C, Betz-Stablein B, et al. Checklist for Evaluation of Image-Based Artificial Intelligence Reports in Dermatology: CLEAR Derm Consensus Guidelines From the International Skin Imaging Collaboration Artificial Intelligence Working Group. JAMA Dermatol 2022;158:90-6.
65. Wongvibulsin S, Yan MJ, Pahalyants V, et al. Current state of dermatology mobile applications with artificial intelligence features: a scoping review. JAMA Dermatol 2024;e240468.

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