

# Space Dermatology: Cutaneous Changes from the Final Frontier

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## Background

- Cutaneous changes induced by space travel are of increasing interest as space exploration becomes more accessible
- Space flight exposes the skin to microgravity and hazardous solar and cosmic radiation<sup>1</sup>
- NASA reports that, although not statistically significant, the rate of both melanoma and non-melanoma skin cancers are increased post-flight<sup>2</sup>
- Understanding these effects could enhance the care of space travelers

## Objectives

- Perform a systematic review of the cellular and clinical studies involving alterations of the skin related to space stressors

## Methods

-  Systematic Review:  
Pubmed and Cochrane databases
-  Search terms: "dermatology OR skin" & "spaceflight OR aerospace OR microgravity"
-  1,186 total articles -> 135 full-text screened  
31 studies included

## Cellular Studies

Gene Expression	-Significant increase in P53 protein on Day 0 of space travel (FC*=1.47) and a significant, but more modest increase in P53 protein with continued space travel (Day 9: FC*=1.36) -Upregulation of genes protective against oxidative stress: Gsta1, Gsta2, and Hmox1 -Downregulation of cytoskeleton remodeling genes: Actg2, Acta1, Cnn1, Fhl1
Signaling Molecules	-Upregulation of IL-1RA, Smad3, and growth factors: PDGF-alpha, TGF-beta -Downregulation of connective tissue growth factor, Wnt/B-catenin signaling, and phosphorylation of extra cellular regular protein kinases 1/2 (ERK1/2)
Collagen and Skin	-Decrease in dermal thickness and keratinocyte diameter -Procollagen decreased over 24 hours of simulated microgravity, but increased over 91 days in space -Increase in type III collagen over 24 days in space, while 20 hours of simulated microgravity showed no changes in collagen-type -Increase in overall collagen synthesis

## Clinical Studies

Neoplastic	-1.5x higher incidence of melanoma (95% CI: 1.26-4.52) -4.1x higher death rate of melanoma (95% CI: 1.05-14.85)
Occupational Hazards	-Increased traumatic injuries (e.g. friction-induced sores, hematomas, and abrasions) -7 HSV reactivation events among 47 astronauts (14.8%) -23 skin rash/hypersensitivity events among 46 astronauts (50%)
Microbiome and Infectious	-Increase in skin microbiome diversity with 1 year isolation in confined environment -Malassezia fungi colonization increased (FC= 5.2-9.5) in various body sites including cheek and chest, during space flight, resembling seborrheic dermatitis -Improvement in skin hydration and skin barrier function -No changes in skin density, thickness, elasticity or appearance of skin after 4 months in space, but decreased skin stiffness and elasticity after 24 hours under simulated microgravity -Skin hypersensitivity in 6 out of 11 astronauts (54.5%)
Cutaneous	-Changes in skin volume are correlated with the skin parameters roughness (r = .50414, P < .0001), scaling (r = .77421, P < .0001) and wrinkles (r = -0.57024, P < .0001) during space travel -Lower leg and forearm skin blood flow increases in the immediate period after head-down tilt bed rest, and decreases after prolonged exposure, possibly linked to a cephalad fluid shift followed by dehydration -Cheek skin blood flow decreased during a -30 degree head-down tilt best rest, suggesting increased vascular resistance due to facial skin constriction and venous congestion

\*FC=fold change

## Conclusions

- Research conducted in space or under simulated space conditions has shown that astronauts are susceptible to melanoma, traumatic injuries, hypersensitivity, skin rashes, and skin thinning
- These findings suggest that astronauts should be carefully screened for skin cancer and other skin diseases before and after their space journeys
- Adequate supplies should be sent with astronauts to space to care for potential injuries and rashes
- These findings highlight the importance of dermatologists being at the forefront of space travel as commercial spaceflight increases
- Limitations of this study include the small sample size of many studies, the variation in duration and space environment, some lack of consistency among studies, and the exclusion of review articles
- Further studies are needed to aggregate more data to better explore the impact of space on skin

## References

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2. Medical Examination Requirements (MER) for former astronauts. NASA. December 5, 2023. Accessed January 14, 2024. <https://www.nasa.gov/general/medical-examination-requirements-mer-for-former-astronauts/>.

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