# Gender Differences with Respect to Electromagnetic Power Absorption in Human Skin Tissue at 5G/6G Frequencies

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**Abstract** – In recent years, the need for technical applications with faster and more reliable data transfer has placed the 5G/6G frequency band at the center of scientific research. Consequently, the possible impacts of increased exposure to millimeter wave (mmWave) radiation on human health are causing growing concern. Thus, taking into account the biological properties of the skin tissues, research and comprehension of the effects of such physical exposure on human skin are necessary. It is shown that the epidermis and dermis tissue layers that make up the skin -the largest organ in the human body [1]- have different thickness in each gender [2], and as a result, the skin of each gender will react differently to exposure to electromagnetic (EM) radiation. In this study, human skin was homogeneously modeled in six different body parts (abdomen, back, breast, dorsum of foot, dorsum of hand, and scalp) of male and female individuals of a human population of the same ethnicity in four layers as shown in Fig.1. The gender effect in the corresponding integrated absorbed power and penetration depths was examined using simulation results from the exposure of the twelve human skin models described above to integrated EM waves in the 5G/6G frequency ranges.

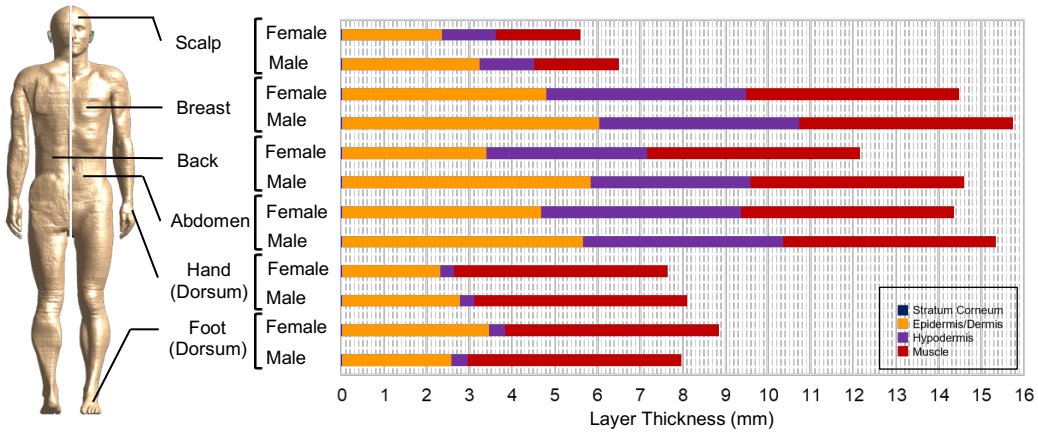


*Fig.1: The skin thickness for both genders* [2-5]*. The phantom taken from ©Sim4Life* [6].

**Result:** According to the results of the simulations, gender-based differences in power absorption were identified in four different tissue layers in six different anatomical regions at frequencies between 3-25 GHz. The stratum corneum (the outermost layer of the skin) has minimal power absorption capacity due to its low conductivity, water content and thickness, with gender differences in absorption being negligible. Gender-specific differences were especially prominent in the epidermis/dermis, where the absorbed power was highest. Particularly, in the back region, where there is the most significant difference in epidermis/dermis thickness between genders (males' backs 2.42 mm thicker), gender-based the power absorption difference reached a maximum at 4.8 GHz, and higher absorption was observed on males' backs than females'. In the hypodermis, which is lie under the epidermis/dermis, the absorbed power in six different body regions of female samples were higher than in the same layer of male samples. The foot (dorsum), where males' skin is 26% thinner female skin, was the only body site in which the absorbed power in muscle tissue was higher in females' than in males'. The penetration depth of the electric field (the distance within the body where the electric field strength decreases to 1/e times the initial value at the skin boundary) were calculated for twelve skin models. It is worth noting that gender-based differences were also obvious

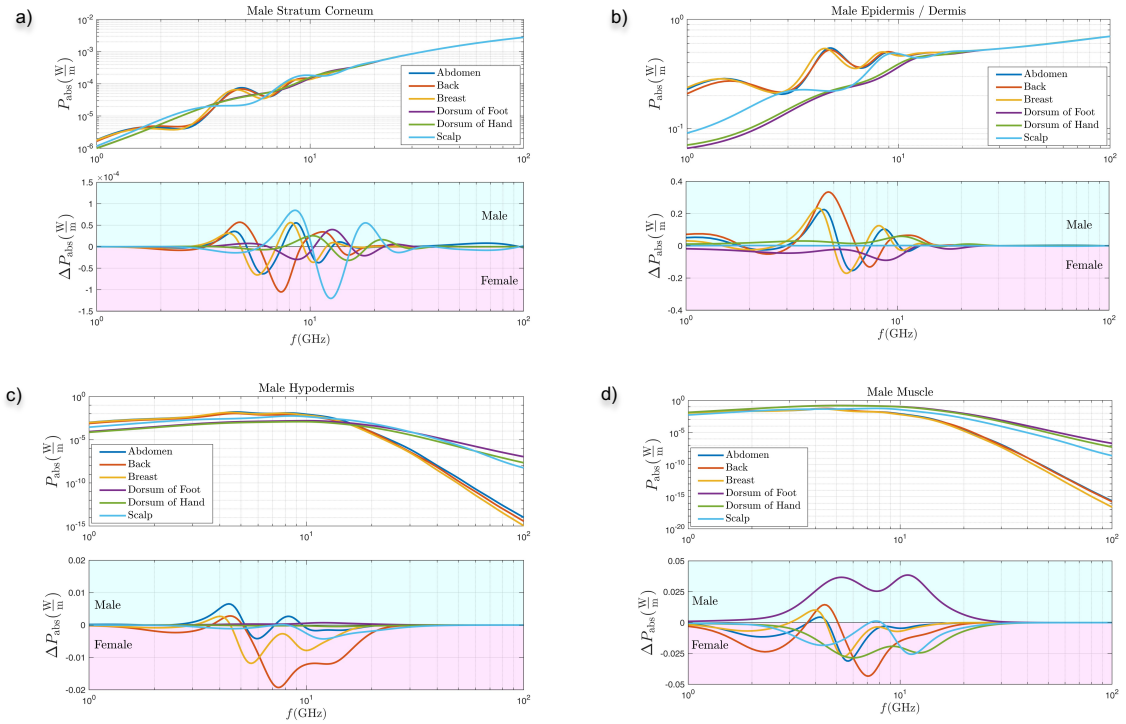


*Fig.2: The integrated absorbed power in males' skin layers (top), and absorption difference between in genders' skin layers (bottom).*

between 1-6 GHz, in which the penetration depths were larger than at higher frequencies. At 6 GHz, the electric field penetrated the hypodermis in the back, chest, and abdomen for both genders, with deeper penetration in males' body. Especially at 6 GHz, the highest penetration depth of the electric field was calculated as 9.9 mm in the males' breast, while it was as 8.5 mm in the females' breast. In the relatively thinner thicknesses of the foot (dorsum), hand (dorsum), and scalp, the electric field penetrated to the muscle in both genders. In all anatomical regions examined for both genders, the penetration depths at frequencies of 24 GHz and above were at maximum around 1.1 mm and thus confined to the epidermis/dermis layer. This highlights the need for thorough investigation into temperature increase in the epidermis/dermis, given the high-power absorption at these frequencies.

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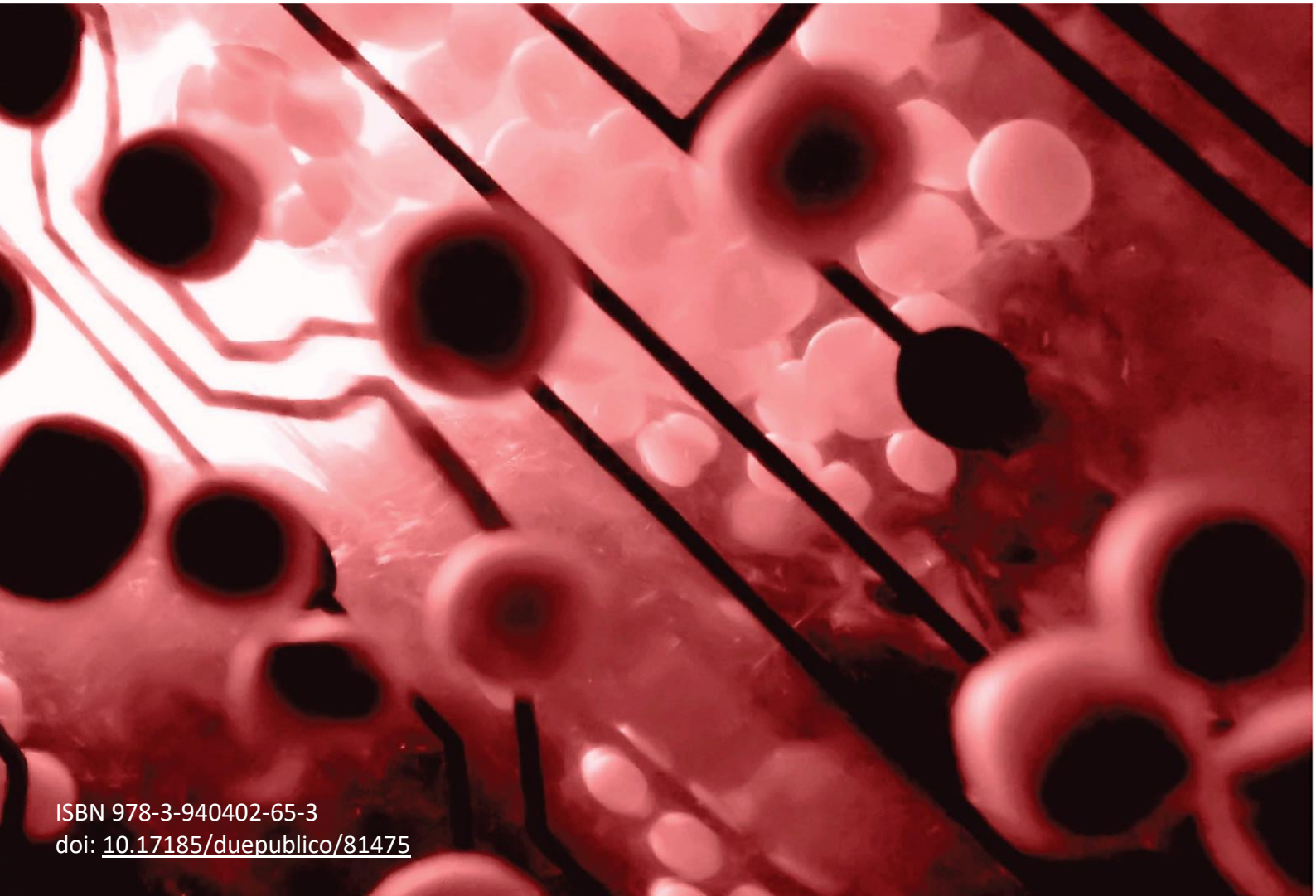

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