Prysm iO Validation Study: Correlation Between Serum and Skin Levels of Carotenoids

BACKGROUND

Prysm iO is a nutritional assessment device that utilizes hyperspectral absorption technology to measure carotenoids, a class of antioxidants abundant in fruits and vegetables that play a critical role in protecting the body from oxidative stress. Prysm iO provides a skin carotenoid score (SCS or score) with a numeric value and color (for more details, see appendix). Because carotenoids reflect dietary intake of fruits and vegetables that are beneficial for human health, they serve as an important biomarker of nutritional status and overall antioxidant capacity[1].

Traditionally, circulating carotenoid levels measured in the blood have been considered the gold standard for assessing fruit and vegetable consumption. This has been noted by the National Academy of Sciences: *"blood concentrations of carotenoids are the best biological markers for consumption of fruits and vegetables"*[2]. However, blood-based carotenoid assessment is invasive, inconvenient, costly, and can be confounded by short-term variability associated with recent food intake. Advances in optical technology have enabled noninvasive measurement of carotenoid levels in the skin using spectroscopic methods.

The BioPhotonic Scanner (S1, S2, and S3 editions) employs resonance Raman spectroscopy to measure skin carotenoids. Its performance was validated in a pivotal clinical study, in which skin carotenoid scores as measured by the S1 demonstrated a strong positive correlation with serum carotenoid concentrations[3]. Since its introduction in 2003, this technology has provided a scientifically validated alternative to blood testing of carotenoids and has been used globally to generate a substantial carotenoid measurement database. This database highlights how carotenoid levels correlate with other dietary, lifestyle, fitness, and supplementation habits[4].

Despite its success, the cost and technical complexity of resonance Raman devices have limited widespread adoption. Prysm iO was designed to address these limitations by offering a more accessible, portable, and affordable optical measurement platform while maintaining scientific rigor. Prior research has shown that resonance Raman spectroscopy (via the BioPhotonic Scanner) and hyperspectral absorption technology (via Prysm iO) detect comparable changes in skin carotenoid scores following supplementation with a multivitamin/mineral product containing carotenoids and other phytonutrients[5]. Yet, further validation was needed to assess the correlation between serum levels of carotenoids and Prysm scores.

OBJECTIVES

The primary objective of this study was to assess the validity of Prysm iO by correlating skin and serum levels of carotenoids. Other objectives of this study included assessing the correlation between serum carotenoids and BioPhotonic Scanner S3 scores and assessing the correlation between Prysm iO and S3 scores.

DESIGN

Principal Investigator Zoe Draelos, MD, FAAD, a clinical and research dermatologist, led the study. A total of 97 participants completed all study assessments. The mean participant age was 49 years (range: 22–77). The study population included 28 males and 69 females and represented diverse ethnic backgrounds, including Asian (n=23), Hispanic (n=11), and Caucasian (n=63). Participants also reflected a broad distribution of Fitzpatrick skin types: Type I (n=20), Type II (n=40), Type III (n=13), Type IV (n=10), Type V (n=12), and Type VI (n=2). Skin Fitzpatrick types are a classification of skin types based on reaction to UV light, and skin tone or color from the palest or lightest (Type I), to the darkest (Type VI).

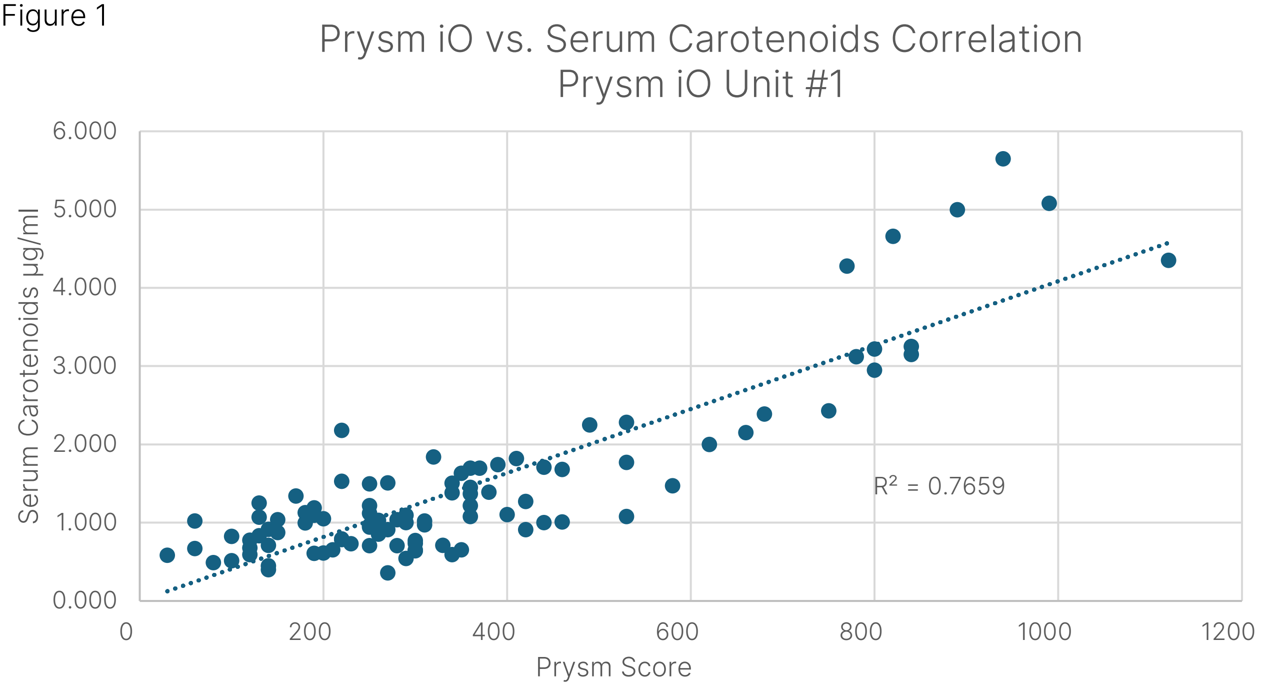
Subjects underwent venipuncture for quantification of circulating carotenoids via high-performance liquid chromatography (HPLC), as well as noninvasive skin carotenoid measurements using both the Prysm iO and the BioPhotonic Scanner S3. For device-based assessments, participants placed their index fingertip on the measurement lens of each instrument to obtain skin carotenoid score readings. S3 measurements were performed once per participant, with each scan requiring approximately 30 seconds. Prysm iO measurements were also performed once per participant on two separate Prysm devices, with each scan lasting approximately 15 seconds.

RESULTS

PRYSM IO VS SERUM CAROTENOID CORRELATION

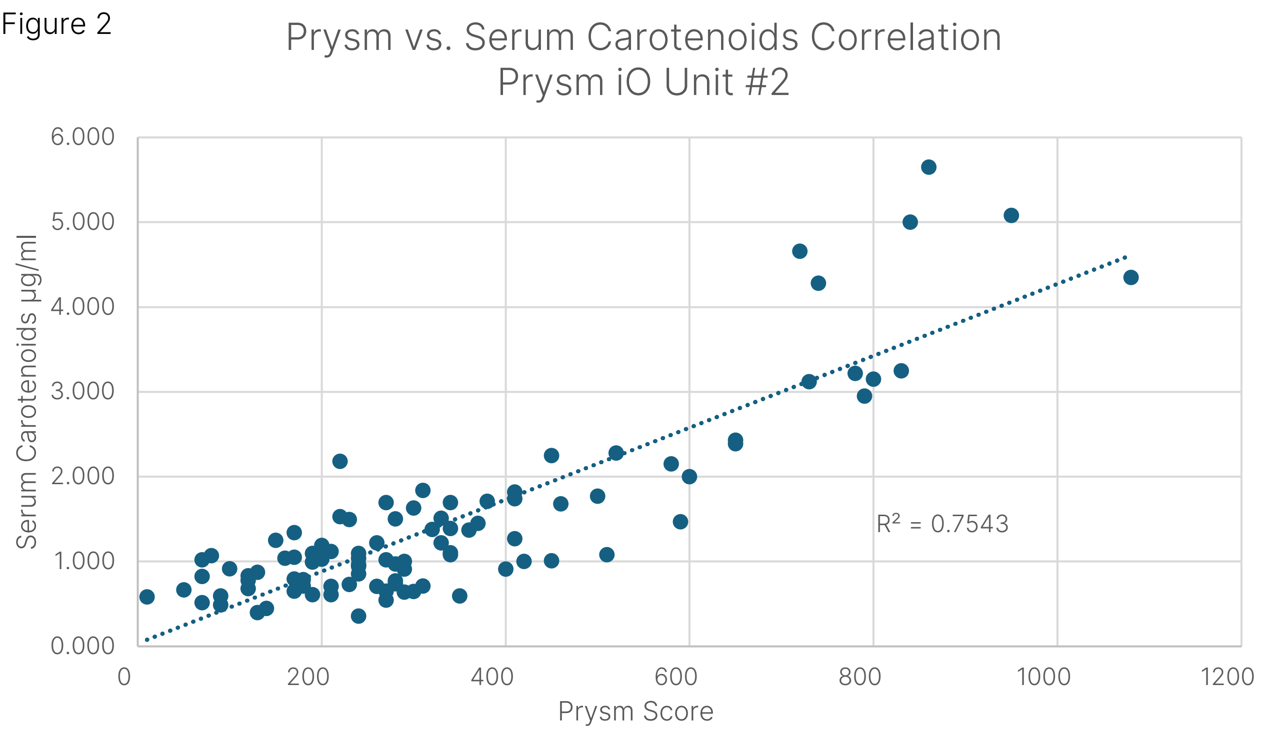
Because two separate Prysm iO devices were used in this study, separate scatterplot graphs were created for each unit. The scatterplot for the first unit used demonstrates a strong positive linear relationship between Prysm skin carotenoid scores and serum carotenoid concentrations (µg/mL). As Prysm values increase, serum carotenoid levels rise correspondingly, indicating good agreement between the noninvasive Prysm measurement and circulating carotenoid levels. In the first figure, increasing Prysm scores are closely associated with higher serum carotenoid levels ($R^2 = 0.77$). In simple terms, R^2 tells you how much of what you're trying to measure (i.e. serum carotenoids) can be statistically explained by what you're using to predict it (i.e. Prysm scores). Although slightly greater variability is evident at higher values, the overall trend is consistent (Figure 1). The mean serum level of carotenoids was 1.46 µg/ml (ranging from 0.36 to 5.65 µg/ml). The average Prysm score was 373 (ranging from 49 to 1112).

Figure 1



The scatter plot for the second unit used, shows a strong positive association between Prysm scores and serum carotenoid concentrations, similar to the first unit. Higher Prysm scores are associated with higher circulating carotenoid levels, while lower Prysm scores are associated with lower serum carotenoid levels. This reflects a clear linear relationship ($R^2 = 0.75$). This demonstrates similar performance across instruments and supports the use of Prysm iO measurements as a reliable estimate for systemic carotenoid status (Figure 2). The mean serum level of carotenoids was 1.46 µg/ml (ranging from 0.36 to 5.65 µg/ml). The average Prysm score was 353 (ranging from 30 to 1070).

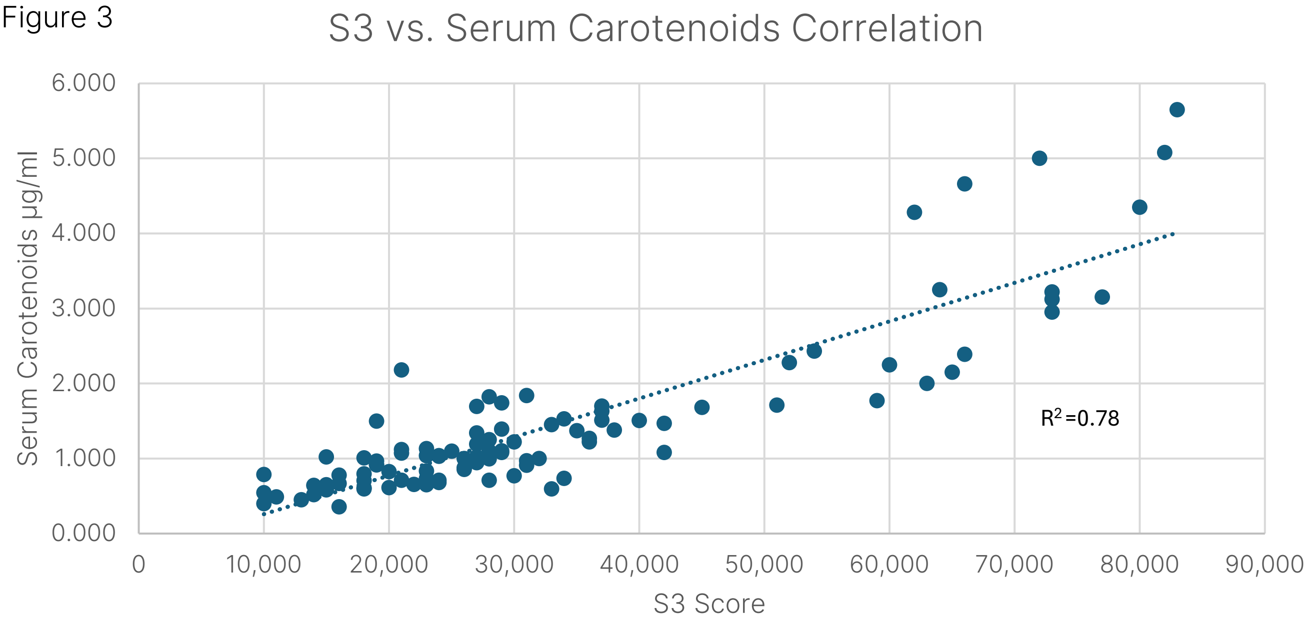
Figure 2



BIOPHOTONIC SCANNER VS SERUM CAROTENOID CORRELATION

The BioPhotonic Scanner (S3 version) versus serum carotenoid scatterplot also demonstrates a strong positive linear relationship between noninvasive skin carotenoid measurements and serum carotenoid levels (Figure 3). This indicates a good agreement between the BioPhotonic Scanner and serum levels of carotenoids. As S3 values increase, serum carotenoid levels rise in a largely proportional manner (R^2 = 0.78). Importantly, the strength and linearity of this association are consistent with those observed in the Prysm device plots, which similarly show strong positive correlations. The mean serum level of carotenoids was 1.46 µg/ml (ranging from 0.36 to 5.65 µg/ml). The average BioPhotonic Scanner S3 score was 33,392 (ranging from 10,000 to 83,000).

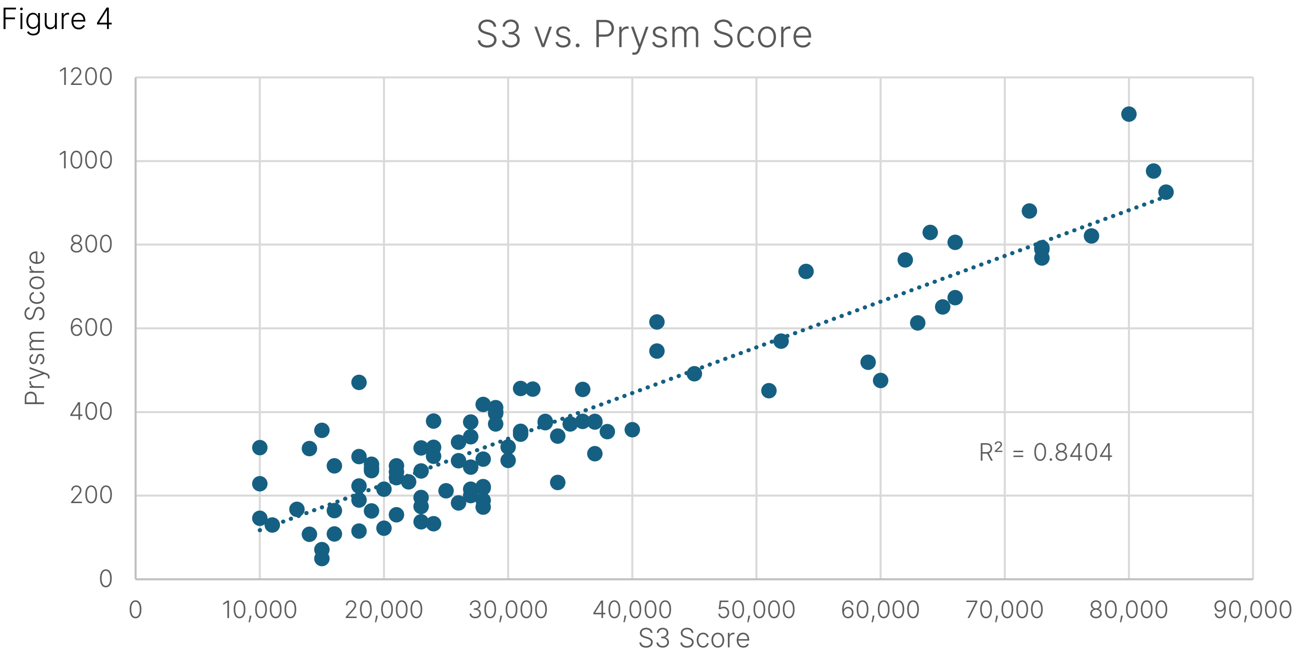
Figure 3



PRYSM IO VS S3 CORRELATION

In addition to evaluating Prysm iO and BioPhotonic Scanner S3 scores correlated with serum carotenoid concentrations, the correlation between Prysm iO and BioPhotonic Scanner S3 scores was also evaluated. The scatterplot demonstrates a strong positive linear relationship between Prysm iO measurements and S3 values across the observed range. As S3 values increase, Prysm scores rise proportionally, with the fitted line capturing this trend and an associated strong correlation (R^2 = 0.84). The relatively tight clustering of data points around the regression line suggests good agreement between the two measurement methods. Overall, these findings support a high degree of confidence between Prysm iO and BioPhotonic Scanner S3 scores, reinforcing the validity of Prysm iO as a robust and reliable measurement approach relative to the previously established BioPhotonic Scanner. Please note that although data from the second Prysm unit is not shown, its scatterplot (R^2 = 0.83) was nearly identical to that of the first Prysm unit demonstrating comparable performance and reinforcing the reproducibility and consistency between the two devices (Figure 4).

Figure 4



DISCUSSION

The present study evaluated the relationship between noninvasive skin carotenoid measurements and serum carotenoid concentrations across different optical devices: two separate Prysm iO devices and the BioPhotonic Scanner (S3 version). In all cases, skin carotenoid scores were strongly and positively associated with serum carotenoid levels, demonstrating the effectiveness of these devices as reliable methods for estimating circulating carotenoid levels. The statistical models explained a substantial proportion of variance in serum carotenoids ($R^2 \approx 0.75$–0.78), which is consistent if not better than prior validation work[3,7].

The strong positive correlations between Prysm iO and serum carotenoids are relevant for a wide demographic of skin types. Prysm iO incorporates a proprietary algorithm that adjusts for variations in skin type and pigmentation, ensuring accuracy and reliability across diverse populations. This proprietary algorithm helps to overcome traditional limitations of reflection-based spectroscopy devices. By reliably estimating systemic carotenoid status without the need for invasive blood draws, this approach offers an accurate alternative regardless of skin color.

The two Prysm iO devices exhibited nearly equivalent performance, indicating reproducible measurements across instruments. This reproducibility across units supports the quality control and precision of the Prysm iO platform for both research and consumer use, providing confidence that observed differences in carotenoid levels reflect true biological variation.

Biologically, skin carotenoid scores represent a person’s cumulative exposure to carotenoids over several weeks to months, as carotenoids accumulate in lipid-rich tissue compartments over time. Serum carotenoids, while responsive to recent dietary intake (i.e. days), exhibit more short-term variation, which may partly account for some of the variability in the statistical models.

Lastly, the study showed a strong positive linear relationship between Prysm iO measurements and BioPhotonic Scanner S3 scores. As BioPhotonic Scanner S3 scores increase, Prysm scores rise proportionally, with a strong correlation ($R^2 = 0.84$). This reinforces that users can switch from the BioPhotonic Scanner to the Prysm iO with confidence in the accuracy of its measurement.

CONCLUSION

The data gathered in this study demonstrate that noninvasive optical skin carotenoid measurements obtained via two Prysm iO instruments and a BioPhotonic Scanner S3 are strongly and consistently associated with serum carotenoid concentrations. The consistency of these associations across devices reinforces the validity and reproducibility of both measurement methods, and it supports the Prysm iO's use as a practical estimate for systemic carotenoid status. These findings align and expand upon scientific literature reporting significant correlations between skin carotenoid scores and serum carotenoids[2,6]. Prysm iO and BioPhotonic Scanner S3 scores also demonstrate a strong positive correlation to each other, helping to bridge the transition from the BioPhotonic Scanner S3 to Prysm iO for both research purposes and for use by consumers.

REFERENCE

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APPENDIX:

WHAT DOES MY SKIN CAROTENOID (SCS) MEAN?

Based on a distribution of skin carotenoid scores, a reference scale was created to capture an individual's response. This scale provides a number and color for ease of tracking and comparing scores over time. The lower an individual scores on the scale, the lower the antioxidant defense, while a higher score represents increased antioxidant defense. Red (0-199) represents low scores, orange (200-299) is lower, yellow (300-399) is moderate, green (400-549) is moderate to high, blue (550-749) is higher, and purple (750+) is highest.