Current Field Use of Reflection Spectroscopy-Based Skin Carotenoid Assessment in Children: Systematic Review

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Background
Skin carotenoid level is a nutritional biomarker—established as a proxy measure for carotenoid-rich fruit and vegetable consumption (FVC).1

Non-invasive Methods to Assess Skin Carotenoid Score (SCS):
- Resonance Raman Spectroscopy (RRS) is established as a valid tool and widely used in research.1
- Pressure-mediated Reflection Spectroscopy (RS): Newer technology validated with RRS and plasma carotenoids.2

Advantages of RS over RRS:
- RS can measure SCS with minimal invasive methods to Assess Skin Carotenoid Score
- RS is a small tool and easy to transport to community research settings.
- Unlike RRS, laboratory set up and equipment are not required for RS.

Literature Gap:
- RS has become a widely acceptable method to quantify children’s FVC in research and public health screening.2,3 However, to date, no studies have systematically evaluated the field use of RS in children.

Objectives
1. Describe the research use of RS-based SCS assessment in children (1-10 years).
2. Summarize reliability and validity of RS-based SCS assessment in children as a proxy for FVC.
3. Identify areas and opportunities for future research with RS-based SCS assessment in children.

Methods
PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement was followed.

Inclusion Criteria:
- Participants were children (1-10 years).
- Participants’ SCS were assessed using RS.
- Original study published in English, peer-reviewed journal.

Risk and Bias Assessments Tools:
- Intervention and observational studies were assessed using the US National Heart Lung and Blood Institute study quality assessment tool.
- Observational studies were also assessed using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.

Results
1. Included studies: N= 8; 1 Intervention & 7 cross-sectional studies.
2. RS Devices Used: (a) Veggie Meter® (Longevity Link Co.) (b) LED-based compact scanner system (Opsoquant GmbH, Kassel, Germany).
3. Demographic Characteristics Across Studies:
   - Age range: 2-14 years.
   - Gender: 48-57% Male children.
   - Race & Ethnicity: White (68-80%); Black(7-86%); Asian (0-54%); Others (3-13%); Hispanic (2-100%).
4. Risk of Bias: High (2), Moderate (2); Low (4).
5. Uses of RS-based SCS Across Reviewed Studies: Cross-sectional Study (N=7)
   - Assessed SCS in different demographic groups, such as age, gender, and weight categories.
   - Determined correlation between FVC and RS-based SCS (Table) and identified covariates for SCS in children.
   - Intervention Study
     - Investigated changes in SCS to determine intervention effectiveness to increase FVC.
   - Significant Correlates:
     - Seasonal variation. Higher SCS in fall and summer compared to winter.
     - Gender. Male children had higher SCS than female children.
     - Body fat percentage. Negatively correlated with SCS.
6. Validity & Reliability:
   - No studies determined validity and reliability of RS to measure SCS in children.

Table. Correlation Values between Fruits and Vegetable Consumption & Skin Carotenoid Score

<table>
<thead>
<tr>
<th>Measures Used</th>
<th>Statistics</th>
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<tbody>
<tr>
<td>7-days diet recall</td>
<td>r = 0.25; p&lt;0.05</td>
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<tr>
<td>Self-reported School Physical Activity and Nutrition survey</td>
<td>r = 0.17; p=0.042</td>
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<tr>
<td>Pictorial Liking Tool</td>
<td>r = [-0.1 to -0.1]; p&lt;0.05</td>
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<tr>
<td>24-hour dietary recall interview</td>
<td>r = 0.27 p&lt;0.05</td>
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Discussion and Implications
1. Studies (N=4) emphasized the need for establishing validity and reliability of the RS-based SCS in children to proxy measure FVC.
2. Future research is required to quantify unit changes in RS-based SCS for assessing unit changes in daily FVC.
3. Inconsistencies in methods to collect RS-based SCS data from children warrant following standard protocol published by Radtke et al. (2021).# Future research and public health programs may benefit from following the standard protocol to measure and report SCS using RS devices.
4. Seasonal and demographic group differences of SCS may provide important information regarding children’s FVC from different minority population groups and low-income families. This has important implications for school meal programs and public food programs.
5. RS could potentially remove bias and bring more equity to dietary assessment, as it excludes memory dependency and allows researchers to collect data from participants with racial and ethnic diversity.

References