Exploring Determinants of Plasma Retinol and Beta-Carotene Levels: The Role of Personal Characteristics and Dietary Intake

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Abstract

This is a test abstract.

1 Introduction

Vitamin A is an essential nutrient that supports critical physiological functions, including vision, immune response, reproduction, and cellular communication(Blaner, 2020; Ross, 2014; Institute of Medicine, Food and Nutrition Board, 2000). Retinol is the major biomarker used to assess vitamin A levels in humans(Blaner, 2020). It plays an essential role in maintaining healthy skin, supporting immune function, and regulating gene expression(Huang et al., 2018). Beta-carotene can be enzymatically converted to retinol in the body, making it an important dietary source of vitamin A(Grune et al., 2010). In addition, beta-carotene also acts as a powerful antioxidant(Fiedor and Burda, 2014).

This study analyzes data from a cross-sectional study designed by Therese Stukel, which includes 315 patients who underwent elective surgical procedures over a three-year period. These procedures involved biopsies or the removal of non-cancerous lesions from organs such as the lung, colon, breast, skin, ovary, or uterus(Nierenberg et al., 1989).

Given the known associations between plasma levels of vitamin A and the risk of various cancers, understanding the determinants of plasma retinol and beta-carotene levels is critical. Investigating factors such as personal characteristics (e.g., sex, age, smoking status, BMI) and dietary intake (e.g., retinol, beta-carotene, and calorie consumption) will provide invaluable insights into the biological and lifestyle influences on these important biomarkers.

2 Methods and Results

We first created various visualizations as part of our exploratory data analysis to help understand who is in the data and acknowledge potential sources of bias within the data.

2.1 Outcome Variable of Interest (`retplasma`, `betaplasma`)

The variables `retplasma` and `betaplasma` represent plasma beta-carotene and retinol levels in ng/mL respectively. According to the summary statistics, both variables exhibit large ranges, suggesting heterogeneity in the population. Skewness is evident in histograms of these two variables, particularly for `betaplasma`. The wide range and skewness suggest the need for a log transformation to normalize distributions and stabilize variance.

2.2 Personal Characteristic Variables (`sex`, `age`, `smoke`, `bmi`)

The dataset includes several personal characteristics that may influence plasma retinol and beta-carotene levels.

- **Age**, a numerical variable, ranges from 19 to 83 years, with a median of 48 years and a mean of 50.18 years, indicating a slightly right-skewed distribution where older individuals are slightly overrepresented.
- **Sex** is a categorical variable, with the majority of participants being female (272 out of 314 individuals), highlighting a potential gender imbalance in the dataset.
- **Smoking status (smoke)** is another categorical variable, with most individuals categorized as nonsmokers. Among the participants, about half have never smoked, followed by a significant proportion of former smokers, while current smokers are the least represented group.
- **BMI (body mass index)**, a numerical variable, ranges from 16.33 to 50.40 kg/m^2, with a median of 24.71 kg/m^2 and a mean of kg/m^2, suggesting a slight skew toward higher BMI values. Based on BMI categories, individuals are classified as underweight (BMI < 18.5), normal weight ($18.5 \leq$ BMI < 25), overweight ($25 \leq$ BMI < 30), or obese (BMI ≥ 30). The majority of individuals fall within the normal weight and

overweight categories, with a smaller proportion classified as obese or underweight.

These variables provide a snapshot of the demographic and health-related characteristics of the study population, which may play a role in influencing plasma biomarker levels.

2.3 Dietary Intake Variables

The dataset includes several dietary intake variables that may influence plasma retinol and beta-carotene levels.

- **Vituse** (vitamin use) is a categorical variable, with most participants reporting some level of vitamin use. **Calories** range from 445.2 to 6662.2 kcal/day, with a mean of 1792.8 kcal/day and a median of 1665 kcal/day, indicating moderate variability in daily energy intake.
- **Fat** intake ranges from 14.4 to 235.9 grams/day, with a mean of 76.75 grams/day and a median of 72.9 grams/day.
- **Fiber** intake ranges from 3.1 to 36.8 grams/day, with a median of 12.1 grams/day, suggesting that many participants fall below recommended daily fiber intake levels.
- **Alcohol** consumption shows a heavily right-skewed distribution, ranging from 0 to 203 drinks/week, with a mean of 3.29 drinks/week and a median of 0.3 drinks/week, indicating that most participants consume little or no alcohol.
- **Cholesterol** intake ranges from 37.7 to 814.7 mg/day, with a mean of 240.4 mg/day and a median of 206.2 mg/day, reflecting variability in dietary patterns.
- **Betadiet**, representing dietary beta-carotene intake, ranges from 214 to 9642 μg/day, with a mean of 2189 μg/day, indicating substantial variation among participants. Similarly,

- **Retdiet**, dietary retinol intake, ranges from 30 to 6901 μg/day, with a mean of 825.6 μ/day and a median of 707 μg/day.

These dietary variables exhibit a wide range of values, reflecting diverse dietary habits within the study population, and are critical for understanding their impact on plasma biomarker levels.

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