Assessing Dietary Protein Intake: A Comparative Study of Two Consumer Mail-In Nutrition Test Kits

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Keywords: Protein Intake, Protein Deficiency, Dietary Assessment, Urine Test, Personalized Nutrition, Metabolomics.

Abstract: This study aimed to compare two consumer-grade mail-in nutrition test kits, Flemi Check and VitaNote, in measuring protein intake and identifying protein deficiencies. A total of 18 subjects (10 male, 8 female) aged 19 to 36 years participated. Descriptive statistics revealed that most subjects consumed between 60 and 80 grams of protein per day, slightly below the recommended 80 grams. The Flemi Check test identified 15 subjects as protein-deficient, while the VitaNote test identified 11. A significant disparity in protein consumption measurements was found, with the Flemi Check consistently underestimating protein consumption compared to the VitaNote test for 16 out of the 18 subjects, with a mean difference of 17.11 grams. However, both kits showed good agreement in estimating the recommended daily protein intake, with only a 2-gram difference. Given the high precision of the VitaNote test, the Flemi Check may not be considered as a reliable tool for assessing protein intake.

1 INTRODUCTION

Protein is a crucial macro-nutrient for building and maintaining a healthy body for people across all ages (Antonio et al., 2024; Groenendijk et al., 2019; Wu, 2016; Paddon-Jones et al., 2015). Protein is essential not only for structural components of the body, such as muscles, bones, blood, and skin, but also for regulating body functions, including the production of hormones and immune function (Wu, 2016). Studies have shown that higher protein intake can help treat or prevent a range of diseases (Wu, 2016; Layman, 2009; Layman et al., 2008; Madeira et al., 2021). Conversely, protein deficiency can lead to many health problems, including sarcopenia in the elderly, which is a rick factor for fractures, disability, and frailty (Groenendijk et al., 2019; Granic et al., 2018; Wilkinson et al., 2018; Paddon-Jones et al., 2015).

Despite its importance, many people fail to meet the recommended daily protein intake. Approximate 70% of people across all age groups do not reach their protein targets, which vary based on gender, age, and physical activity levels (Traylor et al., 2018; Wu, 2016; Bauer et al., 2013; Elango et al., 2010). Surveys indicate that many people are unsure about whether they are consuming enough protein or feel that their intake is insufficient.

Recently, consumer-oriented nutrition testing kits, particularly those for protein consumption, have emerged on the market. These services typically involve collecting a urine sample at home and mailing it back to the company for analysis, where urinary metabolites are assessed using proprietary algorithms. Nutritional studies have shown that analyzing urinary metabolites is an effective method for monitoring dietary intake (Rafiq et al., 2021; Posma et al., 2020; Garcia-Perez et al., 2017) and offers potential for personalized nutrition (Ulusoy-Gezer and Rakıcıoğlu, 2024; Cuparencu et al., 2024; Brennan and de Roos, 2023; Adams et al., 2020). Urine samples provide insights into recent dietary intake, reflecting consumption from a few hours to several days (Rafiq et al., 2021). While challenges remain in developing biomarkers for food intake (Beckmann et al., 2020), urine analysis offers several benefits, including improve objectivity (Ottaviani et al., 2024), scalability, and affordability compared to blood tests (Ulusoy-Gezer and Rakıcıoğlu, 2024; Garcia-Perez et al., 2017; Bokhof et al., 2010). This method also provide a non-invasive and practical

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Liang, Z.
Assessing Dietary Protein Intake: A Comparative Study of Two Consumer Mail-In Nutrition Test Kits.
DOI: 10.5220/0013372600003911

In *Proceedings of the 18th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2025) - Volume 2: HEALTHINF*, pages 906-913
ISBN: 978-989-758-731-3; ISSN: 2184-4305

means for individuals to monitor their nutrition (Adams et al., 2020; Liang and Martell, 2015).

These consumer kits promise an easy and accessible way for individuals to track their protein intake without the need for clinical visits or expensive medical testing. However, it remains unclear how reliable the results are across different services. This study aims to investigate the agreement between two popular protein consumption testing kits: Flemi Check and VitaNote. Specifically, the study has two primary objectives. First, we seek to assess the degree of concordance between the two test kits. Given the importance of accuracy and precision in consumer tests, understanding their consistency is critical for users trust. Second, this pilot study aims to estimate the average daily protein consumption of young adults, a group often underrepresented in protein intake research. To the best of our knowledge, this is the first study to directly compare these two kits and provide data on protein consumption levels in young adults through consumer-oriented testing services.

2 METHOD

2.1 Experiment Protocol

Subjects were recruited through the distribution of flyers around the campus of Kyoto University of Advanced Science (KUAS). To be eligible, subjects had to be adults, capable of understanding explanations in English, and able to attend an in-persona briefing in the lab. Exclusion criteria included individuals who had been diagnosed with chronic kidney diseases or those who weighed over 200 kg, as this exceeds the measurement range of the body composition analyzer used in the study. This study was approved by the ethics review board at KUAS.

The experiment began with a one-on-one briefing session in the lab. During the briefing, subjects were first provided with an explanation of the study objectives, data management protocols, and were asked to sign an informed consent form. Subjects were also instructed on how to collect and mail their urine samples. In addition, they completed the questionnaire attached to each test kit as required by the consumer services.

At the end of the meeting, we measured the body composition of the subjects using a Tanita RD-800 body composition analyzer. This device employs dual-frequency technology for accurate body composition measurements with a precision of 50 gram. By utilizing an 8-electrode grip method, the analyzer measures body fat percentage, muscle mass, and muscle score for the entire body as well as for five individual regions: left arm, right arm, left leg, right leg, and torso.

2.2 Test Kits

Two consumer-grade mail-in nutrition test kits were compared in this study. Both test kits analyze urinary metabolites and assess them using proprietary algorithms. Each kit includes a urine collection container, one or two test tubes, a return envelope, and documents outlining the testing procedures as well as instructions for obtaining informed consent. These testing services aim to assist users in making dietary improvements that align with their nutritional needs. For certain population, such as women and the elderly, who may face challenges in meeting their nutritional requirement through food alone, these services can be particularly beneficial. Establishing a consistent and manageable habit of protein intake is expected to help mitigate various health issues associated with protein deficiency, including frailty (Wu, 2016; Layman, 2009; Layman et al., 2008; Madeira et al., 2021).

Subjects collected urine samples using the provided container and test tubes at home, securely close the lid, and place it in the accompanying plastic bag. To return the sample to the testing center, subjects simply placed the urine container in the return envelope and mail it back to the companies. Details of the two test kits are provided below.

2.2.1 VitaNote

The VitaNote mail-in test kit provides a comprehensive analysis of nutrient imbalances through urine samples, allowing users to assess the status of 19 key biomarkers. This includes 17 essential nutrients, such as proteins, vitamins (e.g., Vitamin D, B1, B2, Niacin, and B6), and minerals (e.g., sodium, potassium, and calcium), as well as two health markers: oxidative stress (rust index) and cytokines (conditioning indicator). The kit offers a detailed evaluation of nutrient deficiencies or excesses, with accompanying advice based on results to guide dietary adjustments.

Results are presented on a radar chart in the VitaNote app, allowing users to easily visualize nutrient imbalances. Tapping on each element of the chart provides more detailed information about that specific nutrient. A proprietary evaluation index is calculated based on the intake levels of each nutrient. The VitaNote app also includes educational content on the role of each nutrient, the risks associated with deficiencies or excesses, and food recommendations for correcting deficiencies.

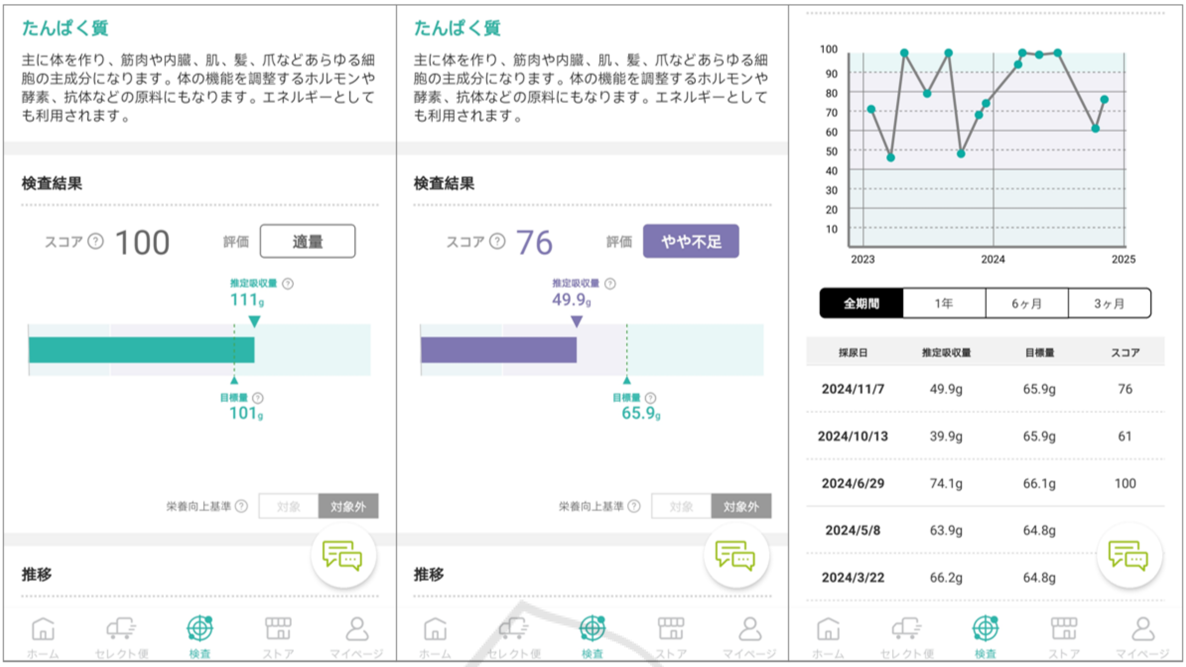

Figure 1: Screenshots of the VitaNote app: Left – an example of sufficient protein intake (111 g versus the recommended 101 g); Middle – an example of insufficient protein intake (49.9 g versus the recommended 65.9 g); Right – a time series plot showing a user's protein intake over time.

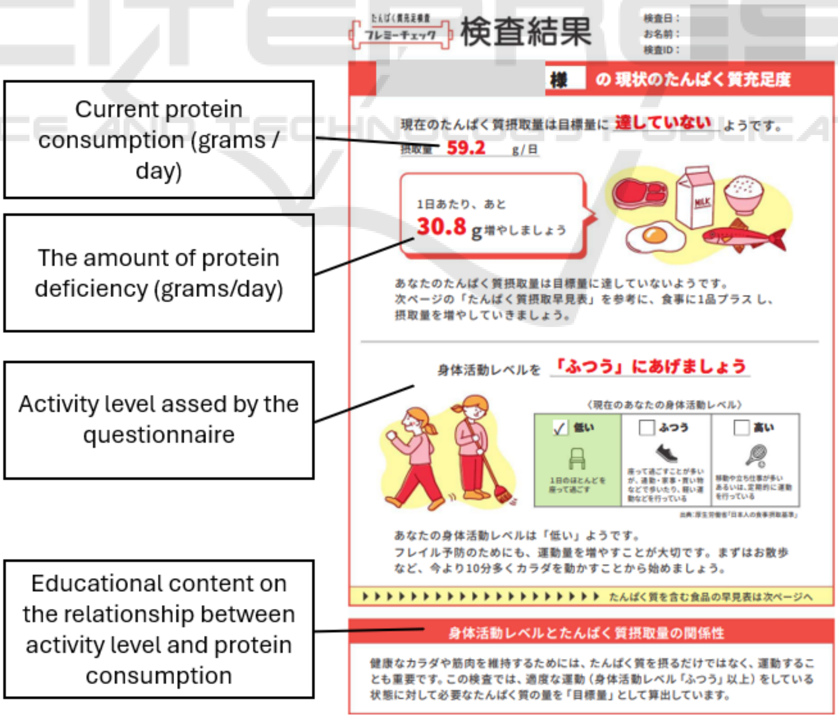

Figure 2: An example of a Flemi Check report showing the current protein consumption, the amount of deficiency, activity level assessed by the questionnaire, and educational content on the relationship between activity level and protein consumption.

For the purpose of this study, we focus solely on the measurement of dietary protein consumption. Some screenshots of the protein measurement results from the VitaNote app are shown in Figure 1. According to the official website, the precision for measuring dietary protein consumption is 0.9% (Yukashikado Inc., 2024). Given the common adopted criteria of 5% allowable error margin (Maduemem and Rodriguez, 2019; Panteghini et al., 2017), the VitaNote test is considered to have good accuracy.

2.2.2 Flemi Check

Similar to the VitaNote test, the Flemi Check mail-in test kit measures dietary protein intake through a urine sample. It provides insights into current protein consumption, guidance on how much additional protein is needed to meet target levels, alongside advice on activity levels and educational content about the importance of protein and its sources. However, the Flemi Check only measures protein and does not assess other nutrients.

An example of a Flemi Check report is shown in Figure 2. The report outlines the protein intake measured from the sample. If intake is insufficient, the report specifies how many additional grams of protein are needed to reach the target. For individuals with adequate intake, the report recommends maintaining their current consumption. The recommended daily protein intake is calculated by combining measured intake and any deficiencies. However, for users who are classified as having sufficient intake, the report does not include information on the recommended daily intake.

2.3 Data Analysis

Histograms were created to visualize protein consumption as measured by the two test kits. This allowed for a visual inspection of the distribution of protein intake for each kit. Bar charts were used to show the number of subjects categorized as having sufficient or insufficient protein intake according to each test kit.

Bland-Altman plots (Bland and Altman, 1986) were created to assess the level of agreement between the two test kits. The mean difference and 95% limits of agreement (1.96 $\pm$ SD of difference) are also shown. In clinical settings, if the differences within the mean equal $\pm$ 1.96 standard deviation are not clinically important, then the two test kits are equivalent and can be used interchangeably (Higgins and Straub, 2006).

3 RESULTS

3.1 Descriptive Statistics

In total 18 subjects (10 male, 8 female) were recruited for the study. The demographic information and descriptive statistics of protein consumption are summarized in Table 1. The age range of subjects was between 19 and 36 years at the time of data collection. Body weight ranged from 51 to 138.5 kg, and BMI values spanned from 18.1 to 41.8 kg/m^2. The majority of subjects reported a medium level of daily physical activity, while two rated their activity level as high and one as low. Fourteen subjects engaged in regular exercise, including activities such as yoga, cycling, weight training, running, and higher intensity interval training (HIIT). All subjects followed an omnivorous diet, with none adhering to a vegetarian or vegan diet. Seven subjects were particularly mindful of their daily protein intake, and four of these were using protein power supplements. The average recommended daily protein intake was approximately 80 grams, while actual protein consumption ranged from 60 to 80 grams. On average, subjects were consuming 10 to 20 grams less protein than the recommended intake.

Table 1: Descriptive Statistics.

Metric	Average	Range
Age (years)	26	[19, 36]
Body weight (kg)	73.41	[51, 138.5]
Muscle mass (kg)	52.8	[40.75, 81.15]
Fat ratio (%)	19.92	[6, 38.3]
Bone mass (kg)	3.04	[2.5, 4.5]
BMI (kg/m^2)	25.07	[18.1, 41.8]
Protein consumption by Flemi Check (g)	61.78	[34.4, 106.4]
Protein deficiency by Flemi Check (g)	19.24	[0, 52.7]
Recommended Intake by Flemi Check (g)	80.73	[65, 99]
Protein consumption by VitaNote (g)	78.89	[30.3, 159]
Protein deficiency by VitaNote (g)	12.33	[0, 48.5]
Recommended Intake by VitaNote (g)	82.59	[62.3, 136.7]

Figure 3 and Figure 4 show the distribution of protein consumption as measured by the two test kits. Both distributions are skewed to the left, but the VitaNote test has a longer tail on the right, indicating a wider range of values, with an outlier at the far right end. Both distributions peak between 40 and 60

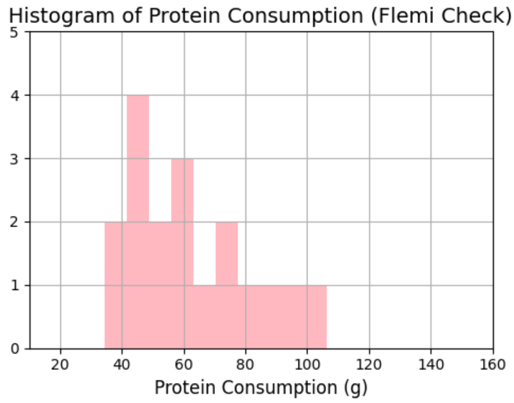

Figure 3: Histogram of protein consumption as measured by the Flemi Check test kit.

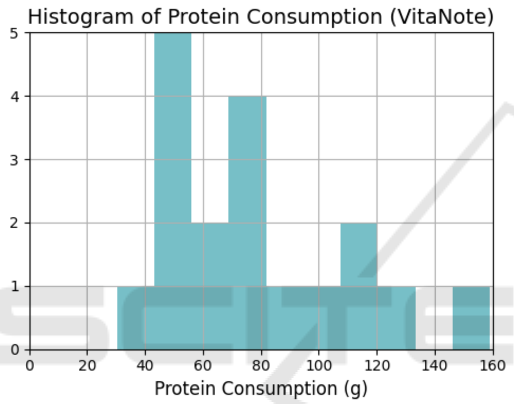

Figure 4: Histogram of protein consumption as measured by the VitaNote test kit.

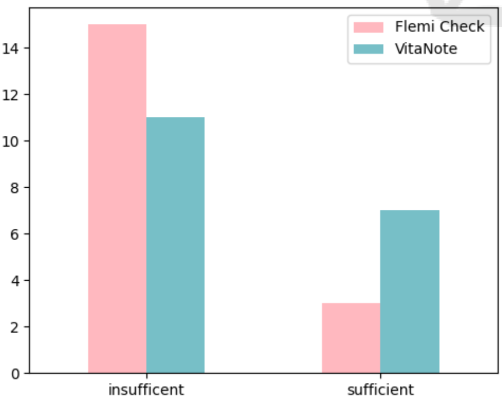

Figure 5: Number of subjects identified as protein-sufficient and protein-insufficient by each test kit.

grams of protein. Correspondingly, 15 subjects were identified as protein-deficient by the Flemi Check test, while only 11 subjects were identified as deficient by the VitaNote test, as shown in Figure 5.

3.2 Agreement between Two Test Kits

As shown in Figure 6, there is a significant disparity between the two test kits in terms of measured protein consumption, with a mean difference of 17.11 grams. The Flemi Check kit underestimated protein consumption for 16 out of the 18 subjects. In addition, the disparity tended to increase as protein consumption levels rose. On the other hand, the two kits agreed reasonably well in terms of the recommended daily protein intake, with a mean difference of only 2 grams, as shown in Figure 7. No significant trend was observed.

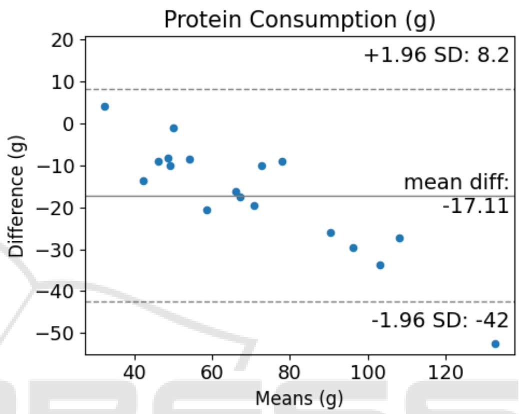

Figure 6: Bland-Altman plot for consumed amount of protein. The solid line show mean difference, and the dotted lines show 95% limits of agreement (1.96 $\pm$) SD of difference.

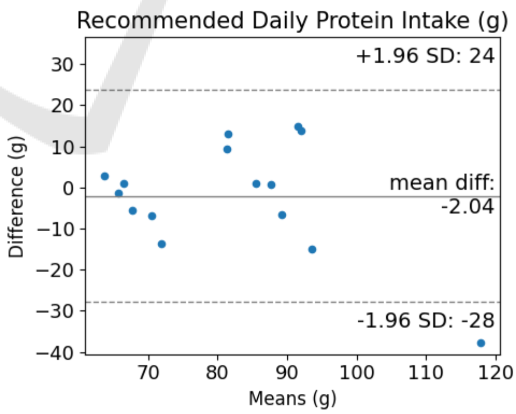

Figure 7: Bland-Altman plot for recommended amount of protein. The solid line show mean difference, and the dotted lines show 95% limits of agreement (1.96 $\pm$) SD of difference.

4 DISCUSSION

Consumer-grade metabolomics test services represent an emerging field in personalized nutrition. As nutritional research transition from population-based to personalized approaches, and from controlled laboratory settings to free-living environments, it is important to evaluate the validity of these testing methods and their impact on consumers. However, there are few studies investigating the validity of urine analysis for measuring protein intake (Bokhof et al., 2010). This study is the first comparative analysis of two popular consumer mail-in test kits–the Flemi Check and the VitaNote–for measuring protein intake and identifying protein deficiencies. Below we discuss the implications of the findings in this study.

Firstly, this study revealed that the overall protein intake of the subjects was slightly below the recommended daily intake of 80 grams, with an average consumption of 60 to 80 grams per day. According to the VitaNote results, approximately 60% of the subjects were not consuming sufficient protein. This finding aligns with other nutrition studies that show many individuals fail to meet recommended protein intake levels (Traylor et al., 2018; Wu, 2016; Bauer et al., 2013; Elango et al., 2010). Interestingly, the Flemi Check test identified a larger proportion of subjects as protein-insufficient compared to the VitaNote test. Specifically, 15 subjects were classified as deficient by the Flemi Check test, while only 11 were identified as deficient by the VitaNote. This discrepancy suggests that the Flemi Check may be more conservative in detecting insufficiency or may have a different threshold for what constitutes a deficiency.

When comparing the two test kits using the Bland-Altman plot, a significant disparity emerged in terms of measured protein consumption. The Flemi Check test consistently underestimated protein consumption compared to the VitaNote test for 16 out of the 18 subjects, with a mean difference of 17.11 grams. This raises concerns about the accuracy of the Flemi Check in capturing actual protein intake. One possible explanation for the lower readings from the Flemi Check kit could be differences in the analysis method used to measure protein. Furthermore, at higher consumption levels, the Flemi Check showed a more pronounced underestimation.

In contrast to the significant differences observed in protein consumption measurements, the two kits showed a much closer agreement when assessing the recommended daily protein intake. The mean difference in recommended intake was only 2 grams, indicating that both kits provide similar estimates for the ideal protein requirements of the subjects. This consistency suggests that both tools may be using a similar formula for assessing general protein needs. Indeed, there are widely accepted methods for estimating protein requirements, which typically suggest 1.2-1.5 grams of protein per kilogram of body weight per day (Wu, 2016; Deutz et al., 2014; Elango et al., 2010), adjusted for factors such as activity level, gender, and age group (Weiler et al., 2023; Vieux et al., 2022; Wu, 2016; Paddon-Jones et al., 2015). No significant trend was observed in this regard, supporting the notion that the two tests are equally effective for determining the nutritional targets rather than actual consumption. However, it is worth noting that while previous study emphasize the importance of factoring in the type and quality of protein consumed (Vieux et al., 2022; Wu, 2016; Wu et al., 2012), it remains unclear whether and how such factors are considered in the analysis of these test kits.

several limitations should be considered. First, the test results were not compared to a gold standard method for measuring protein intake (e.g., validated dietary recalls (Yuan et al., 2017) or 24-hour urinary nitrogen analysis (Bingham, 2003)). Without such a reference, it is challenging to assess the absolute accuracy of either kit. Second, the sample size of 18 subjects is relatively small, which may limit the generalizability of our findings. Future studies should incorporate a medical test as a benchmark for comparison and include a larger, more diverse sample to further validate these results and explore the factors that may influence the accuracy of each test kit.

5 CONCLUSION

In conclusion, while both the Flemi Check and VitaNote test kits provide valuable information on users' protein intake needs, they differ in their ability to assess actual protein consumption. The Flemi Check may tend to underestimate protein intake, particularly at higher levels of consumption, whereas both kits show good agreement in estimating recommended protein intake. Given the high precision of the VitaNote test, the Flemi Check may not be considered as a reliable tool for assessing protein intake.

ACKNOWLEDGEMENTS

The author would like to thank the subjects for their valuable contribution to this study.

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