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Original Research Paper

The relationship between oral *Firmicutes/Bacteroides* ratio, nutritional status, and eating disorder risk in university students

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Abstract
University students are a vulnerable population to developing eating disorders due to the lifestyle and psychological changes during their academic years. The oral microbiome, particularly the *Firmicutes/Bacteroidetes* (F/B) ratio, has been proposed as a potential biomarker for nutritional status, though its relationship in eating disorder risk remains underexplored. This study examined the relationship between the oral F/B ratio, nutritional status, and the risk of eating disorders among university students. A cross-sectional study was conducted on undergraduate students from the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia, from August to October 2024. Saliva samples were analyzed using qPCR to determine the F/B ratio. Nutritional status was assessed via BMI categorization, and eating disorder risk was evaluated using EAT-26 questionnaire. Statistical analyses included Pearson and Spearman correlations. The study included 42 students aged 19-23 years, with the majority (90.5%) being female. Nutritional status was distributed as 11.9% underweight, 52.4% normal, and 35.7% overweight/obese. Eating disorder risk was identified in 38.1% of participants, with all underweight students at risk. The mean oral F/B ratio was 0.704 ± 1.93, significantly associated with nutritional status (p 0.033) but not with eating disorder risk. Higher F/B ratios were observed in overweight/obese participants, whereas lower ratios were observed in underweight status. The oral F/B ratio shows potential as a biomarker for nutritional status among university students but does not directly correlate with eating disorder risk. These findings highlight the complex interplay between microbiome composition, nutrition, and eating behavior related to mental health.

Keywords: eating disorders; oral Firmicutes/Bacteroidetes; F/B ratio; nutritional status; university students

1. Introduction

The oral microbiome, a complex ecosystem of bacteria residing in the oral cavity, plays a vital role in human health beyond oral health alone. This community of microorganisms influences systemic health through the release of metabolites and signaling molecules that affect body systems, including digestion and metabolism (Gao et al., 2018; Peng et al., 2022; Tian et al., 2024). Disruptions in the oral microbiome composition have been associated with systemic conditions, such as cardiovascular disease, diabetes, and obese, highlighting its potential role as a predictor of broader health outcomes (Sedghi et al., 2021; Sampaio-Maia et al., 2016).

Among the bacterial phyla in the oral cavity, *Firmicutes* and *Bacteroidetes* are predominant (Dong et al., 2018). The ratio of these two groups, often used as an indicator of microbial balance, has been shown to correlate with metabolic processes and body weight regulation (Magne et al., 2020; Stojanov et al., 2020). An elevated *Firmicutes*/*Bacteroidetes* ratio has been linked to increased caloric extraction from food, suggesting that shifts in this ratio may contribute to changes in nutritional status (Sutoyo et al., 2020). Certain Firmicutes species, such as *Streptococcus mutans*, are known for their acidogenic potential, which can contribute to oral dysbiosis and inflammation, factors that may indirectly influence eating behaviors (Rajasekaran et al., 2024). On the other hand, some Bacteroidetes species, such as

Porphyromonas gingivalis, have been implicated in periodontal disease, highlighting the complex role of these phyla beyond metabolism (Belibasakis et al., 2023). Although most research has centered on the gut microbiome, recent studies indicate that a similar *Firmicutes*/*Bacteroidetes* imbalance in the oral microbiome could also influence nutritional health (Santonocito et al., 2022; Kato et al., 2017). An increased Firmicutes/Bacteroidetes ratio in saliva may reflect shifts in microbial composition that parallel metabolic changes observed in gut microbiota studies.

Nutritional status is inherently influenced by microbial composition, as microbiota contribute to the digestion and absorption of essential nutrients. Poor dietary intake and nutrient deficiencies can, in turn, alter microbiome diversity and composition, resulting in a feedback loop that influences both nutritional and microbial health (Conlon & Bird, 2015; Mansour et al., 2021). In particular, oral bacteria such as *Firmicutes* are associated with higher adiposity and may reflect dietary patterns characterized by high sugar or processed food intake (Rizzardi et al., 2021). Research indicates that nutritional status is a critical indicator of health, encompassing the balance between nutrient intake and the body's physiological demands. Poor nutritional status can have widespread consequences, affecting physical and mental well-being and potentially heightening the risk of various health conditions, including eating disorder. Underweight individuals, as well as those with higher body mass indexes, can experience body dissatisfaction, potentially exacerbating psychological distress and unhealthy eating behaviors, which can evolve into disordered eating patterns (Eck et al., 2022). Individuals with anorexia nervosa (AN) often have a distorted body image, fearing weight gain despite being underweight, which drives restrictive eating and extreme dieting (Allen et al., 2023). In bulimia nervosa (BN) and binge-eating disorder (BED), dissatisfaction with body shape can trigger cycles of emotional eating, guilt, and compensatory behaviors like purging or excessive exercise (Treasure et al., 2020). Understanding the relationship between nutritional status and eating disorders risk is critical, particularly for developing preventive strategies for vulnerable populations (Barakat et al., 2023).

The *Firmicutes*/*Bacteroidetes* ratio may serve as a biomarker not only for nutritional status but also for potential eating disorder risk, given its implications in energy metabolism and body weight regulation (Helal et al., 2024; Montenegro et al., 2023). Dysbiosis in the oral microbiome, potentially influenced by poor diet or restrictive eating behaviors, may impact metabolic processes, affecting individuals' nutritional profiles and possibly influencing eating disorder susceptibility. By exploring these relationships, this study seeks to shed light on how microbial biomarkers like the *Firmicutes*/*Bacteroidetes* ratio could provide insight into the complex relationship between microbiome health, nutrition, and eating disorders risk.

University students represent a unique population, since the transition to university life often brings significant lifestyle changes, including shifts in dietary habits, increased stress levels, and altered sleep patterns (Almoraie et al., 2024; Buková et al., 2024), all of which can influence both microbial composition and nutritional health (Almoraie et al., 2024; Siddhu, 2024). Additionally, university students are at an elevated risk of developing disordered eating behaviors due to academic pressure, social influences, and body image concerns (Eguren-García et al., 2024). Previous research has shown that young adults frequently exhibit inconsistent eating patterns, including restrictive dieting, irregular meal consumption, and a preference for processed or convenience foods, which may affect microbiome diversity and metabolic function (Clemente-Suárez, Beltrán-Velasco, et al., 2023; Singh et al., 2017).

Despite growing interest in the microbiome's impact on nutritional status and mental health, there is a notable lack of research specifically addressing the oral F/B ratio in relation to eating disorder risk. While an increased F/B ratio has been widely associated with obesity and metabolic disorders, its potential role in disordered eating behaviors remains unexplored. Given the complex interactions between microbiota, nutrient metabolism, and psychological health, investigating the F/B ratio in university students, could provide novel insights into microbial biomarkers linked to eating behavior.

This study aims to investigate the relationship between the oral microbiome, specifically the *Firmicutes*/*Bacteroidetes* ratio, and nutritional status on the risk of eating disorders.

2. Research Methods

This is a cross-sectional study to determine the role of oral microbiome on nutritional status and its implications for the development of eating disorder. According to Dahlan (2016), the calculation for the smallest sample size needed in this study was determined through the correlational analytic formula, which indicated that 38 participants were necessary. A total of 42 individuals from the Faculty of Medicine, Public Health, and Nursing at Universitas Gadjah Mada participated in this research. The research sample was selected using a stratified random sampling method. The sampling process involved classifying the population into major: Medicine, Nursing Science, and Health Nutrition, and then randomly select individuals from each of these majors. Participants selected for the study were active student enrolled in Faculty of Medicine, Public Health, and Nursing. Exclusion criteria comprised individuals who smoked, were on antibiotic medication, and suffered from tooth and mouth diseases. The research was conducted from August to October 2024. Anthropometric measurements and saliva sampling were carried out at the Health Nutrition Building, Universitas Gadjah Mada, for 2 weeks. The saliva were preserved at 4ºC following the addition of 1 ml of RNA stabilizer for every 1 ml of sample, in preparation for future analysis. The stability of RNA for further RNA or DNA targets was stable even after 15 days of storage by adding the stabilizer (Reck et al., 2015). The bacterial analysis was carried out at the Laboratory of the Centre for Tropical Livestock Research, Faculty of Animal Science UGM.

Anthropometric data to determine the nutritional status of students obtained from body weight measured with body weight digital scale and height measurements using microtoise. Nutritional status is determined based on anthropometric data using the Body Mass Index indicator. Risk of eating disorder related to eating behavior is measured using the EAT-26 (The Eating Attitude Test) questionnaire which consists of 26 statements regarding eating behavior associated with the risk of anorexia or bulimia (Sadiq et al., 2023). Calculation of *Firmicutes*/*Bacteroidetes* ratio using saliva samples. Saliva sampling was collected in the morning between 09.00 to 11.00 am, respondents were asked not to eat and drink at least an hour before the sampling time. Before spitting, respondents were asked to gargle for 1 minute using drinking water that had been provided, followed by saliva collection 5 minutes after by spitting 5-10 ml of saliva into a sterile collector tube.

Initial testing was done by extracting salivary DNA using a FavorPrep blood/cultured cell genomic DNA extraction kit. Followed by the process of checking bacteria (*Firmicutes* and *Bacteroidetes*) by quantitative PCR (qPCR) method using Quantstudio 3 qPCR machine (Applied Biosystems). *Firmicutes* bacteria were tested using FirmF (5‘-GGAGYATGTGGTTTAATTCGAAGCA-3’) and FirmR (5‘-29AGCTGACGACAACCATGCAC-3’) specific primers. Meanwhile, checking for *Bacteroidetes* bacteria uses specific primers BactF (5‘-GGARCATGTGGTTTAATTCGATGAT-3’) and BactR (5‘-AGCTGACGACAACCATGCAG-3 (Albedewi et al., 2022). Checking each result uses a bacterial control, namely All Bacteria. The All Bacteria check used specific primers EubF (5‘-ACTCCTACGGGAGGCAGCAG-3’) and EubR (5‘ATTACCGCGGCTGCTGG-3’). The primer selection was designed according to the 16S ribosomal RNA gene sequence (Albedewi et al., 2022).

Data were analyzed with SPSS 26 software using the Pearson test to determine the role of the *Firmicutes*/*Bacteroidetes* ratio in nutritional status, and the Spearman correlation test to identify the correlation between nutritional status and the risk of eating disorder. This study has received approval from the Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada number KE/FK/1290/EC/2024.

3. Results and Discussion

3.1.Characteristics of the study participants

This study explored the relationship between the Firmicutes/Bacteroidetes ratio in oral cavity, nutritional status, and the risk of eating disorder among undergraduate students from Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada. The findings provided insights into the interplay of oral microbiota composition, nutritional status, and the risk of eating disorder in this specific population. The subjects in this study were undergraduate students of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, consisting of Medical Education, Nursing, and Health Nutrition study programs ranging from first to fourth year. As shown in Table 1, most participants were 21-23 years old (73.8%), and the rest were 19-20 years old (26.2%). Participants in the research had a mean age of 21.31 years, with males averaging 22.25 years and females averaging 21.16 years. Among the participants, the majority were Health Nutrition students, followed by Nursing and also Medical students.

The age distribution suggests that the sample predominantly consists of individuals aged 21 to 23 years, which aligns with the typical age range of university students. This gender distribution reflects the higher enrollment of females in Health Science fields, as happened in the US for an increased number of women enrolled in Medical school compared to men (AAMC, 2023). In Universitas Gadjah Mada itself, it was included nearly 60% of female students from all majors.

Table 1. Characteristics of Study Participants

Characteristic	Frequency (n)	Percentage (%)
Age		
19	3	7.1
20	7	16.7
21	11	26.2
22	5	11.9
23	16	38.1
Sex		
Male	4	9.5
Female	38	90.5
Major		
Medicine	4	9.5
Nursing	8	19.0
Nutrition	30	71.4
Study Year		
4th	22	52.4
3rd	8	19.0
2nd	10	23.8
1st	2	4.8

Source: Primary Data, 2024

3.2.Description of Research Variables

Measurement of total *Firmicutes* and *Bacteroidetes* was obtained from the qPCR cycle value (Cq) which was converted by the exponential method into CFU/mL. In calculating total *Firmicutes* and *Bacteroidetes*, the assumption that 100% qPCR efficiency was used. The *Firmicutes/Bacteroidetes* (F/B) ratio was obtained from the total amount of *Firmicutes* and *Bacteroidetes* pre-adjusted to the total expression of All Bacteria. The mean F/B ratio in the study was 0.704 ± 1.93.

Table 2. The Overview of Research Variables

Variable	Mean ± SD	Frequency (n)	Percentage(%)
Firmicutes/Bacteroidetes	0.704 ± 1.93		
Nutrition Status (BMI)	22.5 ± 3.7		
Underweight		5	11.9
Normal		22	52.4
Overweight/Obese		15	35.7
Eating Disorders Risk			
Not at risk		26	61.9
At risk		16	38.1

Source: Primary Data, 2024

Research highlights that a dysregulated F/B ratio in the oral microbiome is often associated with health conditions, including obesity which also linked to low-grade chronic inflammation (Sedghi et al., 2021; Ma et al., 2023). For example, study have shown a lower F/B ratio in healthy individuals compared to those with esophagus squamos cell carcinoma (ESCC) (Chen et al., 2022). Lower F/B ratio also found in Crohn's disease compared with healthy individuals (Elzayat et al., 2023). Specific strains, such as *Lactobacillus* and *Streptococcus* within the *Firmicutes* phylum, have been linked to metabolic imbalances and inflammatory responses in diseased states by reducing inflammatory cytokines and increasing anti-inflammatory cytokines (De Luca & Shoenfeld, 2019). Regarding the *Firmicutes/Bacteroidetes* (F/B) ratio, while the specific numbers can vary based on factors such as diet, health status, and the microbiome's location (oral or gut), some studies have proposed general guidelines for interpreting the ratio (Sutoyo et al., 2020; Noor et al., 2023; Van Hul et al., 2024).

Generally, a higher proportion of Firmicutes relative to Bacteroidetes has been associated with obesity, whereas a higher proportion of Bacteroidetes is observed in leaner individuals (Magne et al., 2020). In the gut microbiome, an F/B ratio of 0.6 to 1.4 is often suggested as typical for healthy individuals (Vaiserman et al., 2020). In children with a normal BMI, the mean oral F/B ratio ranges from 0.46 to 0.48, while obese children tend to have a higher F/B ratio of 0.50 to 0.52 (Rizzardi et al., 2021). Although studies on the oral F/B ratio are less conclusive regarding a specific "healthy" range, similar patterns have been observed, where an imbalance favoring Firmicutes may be associated with dysbiosis or metabolic disturbances (Giordano-Kelhoffer et al., 2022). The findings of this study align with previous research, as a higher F/B ratio was linked to a higher BMI, further supporting the role of microbial composition in metabolic regulation and nutritional status.

The average BMI of the participants was 22.5 ± 3.7 kg/m2, with nutritional status of 11.9% underweight, 52.4% normal, and the rest (35.7%) overweight/obese (Table 2). The diversity in nutritional status among university students, emphasizing the need for targeted interventions to support healthy weight management during academic years (Al-Awwad et al., 2021; Deliens et al., 2016) (Mathunjwa et al., 2024). Nutritional status among university students is a growing concern, as students often experience changes in their diet and lifestyle that can lead to both undernutrition and overnutrition (Jakobsdottir et al., 2023; Yun et al., 2018). University students, especially freshmen year, are at risk of poor nutritional intake due to the transition to independent living, stress from academic pressures, and limited cooking skills. Research indicates that a significant number of students have diets rich in processed items, sugars, and unhealthy fats, while missing out on vital nutrients (Harshman et al., 2019).

On the other hand, students are also at risk of overnutrition. A study in China showed that nearly 23% of the students were overweight or obese (Zhang et al., 2016). A similar number was found in Yogyakarta, Indonesia, where 21% of young adults were obese (Nugraeni et al., 2023). The shift toward unhealthy eating habits, such as increased fast food consumption and reduced physical activity, contributes to this trend. Both undernutrition and overnutrition in university students can have long-

term health consequences. Nutrient deficiencies can impair cognitive function, academic performance, and overall well-being, while obesity and poor diet can lead to chronic diseases such as cardiovascular disease, diabetes, and metabolic syndrome later in life (Drozdz et al., 2021; Naveed et al., 2020). In students, various factors such as stress, lifestyle changes, and body image issues als found to influencing their nutritional status (Hariyanti & Haryana, 2021; Lisnawati & Danefi, 2023).

Regarding the risk of eating disorder, 61.9% of the participants were not at risk, but 38.1% were vulnerable to have eating disorder with EAT-26 scored ≥20. Eating disorders are common among university students, with a significant number of both underweight and overweight students reporting disordered eating behaviors (Escolar-Llamazares et al., 2023; Tavolacci et al., 2021). It was observed that 13-25% of students experience and prone to develop some form of eating disorder, including anorexia nervosa, bulimia nervosa, and binge eating disorder (Eisenberg, 2011; Hasan, 2024). University students are especially vulnerable to body image concerns and dieting behaviors, which are closely linked to eating disorders (Choirunnisa & Harahap, 2023; Mallaram et al., 2023). College students, especially women, are at risk of developing disordered eating habits due to societal pressures related to appearance and weight (Makki et al., 2023; Puspita et al., 2024). In this study, the majority of participants were women, which aligns with existing research indicating that female college students are more likely than their male counterparts to engage in dieting behaviors and experience body image concerns.

3.3.Association of Oral *Firmicutes*/*Bacteroidetes* Ratio, Nutritional Status, and Eating Disorders risk

The *Firmicutes/Bacteroidetes* (F/B) ratio was obtained from the total amount of *Firmicutes* and *Bacteroidetes* pre-adjusted to the total expression of All Bacteria. The mean F/B ratio in the study was 0.704 ± 1.93. The average *Firmicutes/Bacteroidetes* (F/B) ratio across nutritional status and risk of eating disorder was shown in Table 3. The F/B ratio in the underweight group was 0.290-0.079, 0.727-0.065 in the normal nutritional status, and 11.748-0.194 in the overweight/obese group. The result was shown that the highest F/B ratio and mean of F/B ratio was found in overweight/obese group. Participants who were not at risk of eating disorder had an F/B ratio 11.748-0.065, while the respondents at risk had an F/B ratio 0.935-0.054. There was a significant relationship between the F/B ratio and nutritional status, but the F/B ratio and eating disorders risk were not significantly related.

Table 3. The Distribution of *Firmicutes*/*Bacteroidetes* Ratio on Nutritional Status and Eating Disorders Risk

Variable	F/B ratio	r	p
Nutrition Status (BMI)			
Underweight	0.190 ± 0.09	0.329	0.033*
Normal	0.516 ± 2.62		
Overweight/Obese	1.150 ± 0.17		
Eating Disorders Risk			
Not at risk	0.956 ± 2.42	0.208	0.186
At risk	0.292 ± 0.26		

Source: Primary Data, 2024

This finding aligns with research indicating that gut and oral microbiota composition can reflect systemic metabolic states (Kunath et al., 2024; Park et al., 2021). An elevated oral F/B ratio in overweight/obese participants might indicate a microbial composition favoring energy harvest, as has been demonstrated in gut microbiome studies (Magne et al., 2020). Conversely, the lower F/B ratio in underweight participants could reflect an altered microbial balance potentially linked to reduced metabolic efficiency or dysbiosis (Pinart et al., 2022). Research highlights that a dysregulated F/B ratio

in the oral microbiome is often associated with health conditions. For example, studies have shown a lower F/B ratio in healthy individuals compared to those with metabolic conditions like metabolic-associated fatty liver disease (MAFLD) (Niu et al., 2023). Specific strains, such as *Lactobacillus* and *Streptococcus* within the Firmicutes phylum, have been linked to metabolic imbalances and inflammatory responses in diseased states (Islam, 2022). The use of saliva as a non-invasive sample source highlights its potential as a diagnostic tool for studying microbiota-related health outcomes (Noruzpour et al., 2024; Shinde et al., 2024).

Based on Table 4, there is a significant relationship between nutritional status and eating disorders risk. All participants with underweight BMI were at risk of eating disorders, as well as 31.8% of participants with normal BMI and 26.7% with overweight/obese. The association between underweight BMI and heightened risk of eating disorders is well-documented in the literature. Underweight individuals are particularly vulnerable to restrictive eating patterns, often driven by a combination of body image concerns and fear of weight gain (Clemente-Suárez, Ramírez-Goerke, et al., 2023). Prolonged energy restriction and malnutrition can exacerbate the physical and psychological impacts of eating disorders, creating a vicious cycle that demands early detection and targeted intervention (Allen et al., 2023). Treatment approach that emphasize the need for comprehensive care models addressing both nutritional rehabilitation and psychological support in this group (Bray et al., 2023).

The significant risk of eating disorders among individuals with normal and overweight/obese BMI illustrates that eating disorders are not limited to underweight populations. Normal-weight individuals at risk may engage in compensatory behaviors such as purging or excessive exercise, often masking their disordered eating patterns until later stages (Brytek-Matera, 2021). Meanwhile, binge-eating tendencies among overweight and obese individuals are frequently driven by emotional distress, leading to feelings of guilt and shame, as well as cyclical dieting behaviors (Dakanalis et al., 2023; Razzoli et al., 2017).

Table 4. The Relationship of *Firmicutes*/*Bacteroidetes* Ratio and Nutritional Status with Eating Disorders Risk

	Eating Disorders Risk						r	p
	Not at risk			At risk				
	mean	n	%	mean	n	%		
F/B Ratio	0.956	26	61.9	0.294	16	38.1	0.208	0.186[a]
Nutrition Status (BMI)								
Underweight	0	-	0	17.96	5	100	0.330	0.032*[b]
Normal	20.34	15	68.2	21.89	7	31.8		
Overweight/Obese	25.45	11	73.3	29.12	4	26.7		

[a] analysis using Pearson test
[b] analysis using Spearman test
Source: Primary Data, 2024

However, the oral F/B ratio was not significantly associated with eating disorder risk. The participant with no risk of eating disorder had higher F/B ratio in this study. This suggests that while oral microbiota composition correlates with nutritional status, its role in eating disorder risk may be mediated by other factors such as psychological stress, dietary behaviors, or metabolic responses (Anton-Păduraru et al., 2024). While microbial balance is crucial, eating disorders are multifaceted, and microbial changes could be a downstream effect rather than a primary driver. Future research could explore whether other microbial markers or diversity indices, such as Shannon or Simpson diversity scores, correlate more strongly with eating behaviors (Faria et al., 2020; Viljakainen et al., 2020). The absence of a significant relationship between the F/B ratio and eating disorder risk in this study might reflect the complex interplay of psychological, dietary, and microbiological factors.

This study emphasizes the importance of investigating the oral microbiota as a potential biomarker for nutritional status and its role in overall health. While the oral F/B ratio showed a clear relationship with BMI, its lack of association with eating disorder risk suggests a need for further exploration into the mechanisms linking oral microbiota composition, dietary patterns, and mental health. Eating disorders, including anorexia nervosa, bulimia nervosa, and binge-eating disorder, are complex mental health conditions influenced by psychological, biological, and environmental factors (Treasure et al., 2020). These disorders are often associated with anxiety, depression, and obsessive-compulsive tendencies, which can alter dietary behaviors and, potentially, microbiota composition (Barakat et al., 2023). The absence of a direct relationship between the F/B ratio and eating disorder risk in this study may indicate that microbiota imbalances are more closely tied to metabolic health than to the psychological and behavioral components of disordered eating. Future studies should investigate larger, more diverse populations and incorporate additional factors, such as dietary intake, psychological stress, and metabolic biomarkers. Furthermore, interventions targeting oral microbiota through dietary adjustments or probiotics could complement efforts to improve nutritional and psychological health (Berding & Cryan, 2022; Kerstens et al., 2024).

4. Conclusion

This study revealed a significant association between the F/B ratio and nutritional status, with higher ratios observed in overweight/obese individuals and lower ratios in underweight participants. This finding is reflecting potential microbial influences on energy metabolism. However, no significant relationship was found between the F/B ratio and eating disorder risk, suggesting that while microbial composition correlates with BMI, its direct role in eating disorder susceptibility remains unclear. In contrast, nutritional status was significantly linked to eating disorder risk, with all underweight participants at risk and a notable proportion of normal-weight and overweight/obese individuals also affected. This highlights the complexity of eating disorders, which extend beyond underweight populations and involve diverse behavioral patterns. These findings emphasize the need for integrated screening approaches that combine nutritional assessments with psychological evaluations to enhance early detection and intervention. Through this exploration, we hope to contribute valuable insights for early detection and preventive interventions for eating disorder based on microbial and nutritional assessments.

The potential of saliva as a non-invasive tool for studying microbiota-related health outcomes is promising, but microbial markers alone may not be sufficient to predict eating disorder risk. Future research should explore additional microbial diversity indices, specific bacterial strains, and their interactions with dietary habits and psychological factors. Expanding studies to larger, more diverse populations and incorporating longitudinal designs would provide deeper insights into the causal relationships between microbiota, nutrition, and disordered eating behaviors.

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