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"IMPACT OF DAILY FRUIT INTAKE ON DIGESTIVE HEALTHAMONG YOUNG & ADULTS"

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ABSTRACT

Digestive disorders are common among young adults and can significantly impair quality of life. Daily fruit intake, due to its fiber, water, and bioactive compounds, may improvedigestive health, but evidence regarding optimal intake and fruit-specific effects remains limited. This study investigated the association between daily fruit intake and digestive health among young adults by examining digestive symptoms, stool characteristics, dose-response relationships, fruit type differences, and the moderating effects of gender, physical activity, and hydration. A mixed-methods sequential explanatory design was used. A cross-sectional survey of 432 adults aged 18–35 years assessed fruit intake using the Fruit Intake Frequency Questionnaire (FIFQ), digestive symptoms using the Gastrointestinal Symptom Rating Scale (GSRS), stool consistency using the Bristol Stool Scale (BSS), and lifestyle factors. Data were analyzed using ANOVA, ANCOVA, regression analyses, correlations, and repeated-measures ANOVA. Only 28.5% of participants met the recommended intake of at least two fruit servings daily. Higher fruit intake was significantly associated with lower constipation, bloating, abdominal pain, and improved overall digestive health ($p < 0.001$). Benefits became evident at approximately 1.5 servings/day and were greatest at 2–3 servings/day. Pectin-rich fruits demonstrated superior effects on constipation relief. The intervention group showed significant improvement in constipation scores compared with controls ($p = 0.001$). According to study findings, daily consumption of at least two servings of fruit, particularly pectin-rich varieties, significantly improves digestive health in young adults. Combining adequate fruit intake with regular physical activity may provide additional digestive health benefits.

KEYWORDS: Gut microbiota, Bristol Stool Scale, gastrointestinal symptoms, nutritional epidemiology.

INTRODUCTION

Digestive disorders represent a significant public health burden globally, affectingquality of life, productivity, and healthcare utilization. Young adults (aged 18-35 years) areincreasingly affected by functional gastrointestinal disorders, including constipation, bloating, andabdominal discomfort. The relationship between diet and digestive health has beenrecognized since ancient times,with Hippocrates famously declaring that "all diseases beginin the gut". In recentdecades, scientific advances have substantially elaborated this relationship, revealing thedigestive system as a complex ecosystem where dietary components interact with the gutmicrobiota, intestinal epithelium, immune system, and enteric nervous system to influencenot only gastrointestinal function but also systemic health.

Among dietary components,fruits have emerged asparticularly important for digestive health due to their uniquecombination of dietary fiber, fluids, polyphenols, and prebiotic carbohydrates.Common fruits include apples, bananas, oranges, berries, grapes, mangoes,kiwifruit, pears, peaches, and plums, among many others.

The nutritional composition of fruits is remarkably diverse, but several components areparticularly relevant to digestive health. Dietary fiber, including both soluble (pectin,gums, mucilage) and insoluble (cellulose, hemicellulose, lignin) fractions, provides bulk,increases stool weight, accelerates colonic transit, and serves as substrate for microbialfermentation. Fructo-oligosaccharides (FOS) and other prebiotic carbohydratesselectively stimulate the growth and activity of beneficial gut bacteria, particularlyBifidobacteria and Lactobacilli. Polyphenols, including flavonoids, anthocyanins, andtannins, have anti-inflammatory and antimicrobial properties that may modulate gutmicrobiota composition and reduce intestinal inflammation. Water content (typically80-90% of fruit weight) contributes to hydration status and stool softening. Despite these theoretical benefits, fruit intake among young adults has declined in recentdecades, with concurrent increases in processed food consumption and sedentary lifestyles. National dietary surveys indicate that only 20-35% of young adults meet therecommended daily fruit intake of 2-3 servings per day. This decline is concerninggiven that young adulthood is a critical period for establishing long-term dietary habits and that digestive disorders are increasingly prevalent in this age group.

Furthermore, the most available evidence is observational and does not adequately establish causal relationships. Consequently, there is insufficient evidence to develop targeted dietary recommendations for improving digestive health in young adults.The study addresses these research gaps by comprehensively evaluating the impact of daily fruit intake on digestive health using both cross-sectional and experimental approaches. It examines digestive symptoms, bowel habits, dose-response relationships, fruit-specific effects, and the moderating influence of lifestyle factors. The findings provide evidence-based guidance for nutritional recommendations aimed at preventing and managing common digestive disorders in young adults. The study also supports public health initiatives promoting adequate fruit consumption and healthy lifestyle practices, contributing to improved gastrointestinal health, enhanced quality of life, and reduced healthcare burden.

MATERIALS AND METHODS

Study design

The study employed a comparative cross-sectional research design to assess Impact of daily fruit intake on digestive health among young adults. A study was conducted over a specified period using a structured questionnaire to evaluate dietary habits and fruit consumption practices.

StudyPopulationandSample Size

The study population consisted of young adults aged between 18 and 35years. A total of 432 participants were included in the study, comprising participants who were selected based on their willingness to participate and fulfilment of the inclusion criteria.

Inclusion criteria

- Age 18–35 years inclusive
- No self-reported history of chronic gastrointestinal diseases
- No use of prescription laxatives, antidiarrheals agents in past 3 months
- No antibiotic use in the past 4 weeks
- Not following anyrestrictive diet

Exclusion criteria

- pregnancy or lactation,
- current smoking (>5 cigarettes/day)
- alcohol use disorder (AUDIT score ≥15),
- use ofprobiotic supplements in the past 2 weeks
- history of gastrointestinal surgery (exceptappendectomy)
- known allergy to common fruits (e.g., oral allergy syndrome).

SamplingTechnique

A convenience sampling technique was employed for participant selection. Eligible students were approached and invited to participate in the study. Participation was voluntary, and Informed consent was obtained prior to data collection.

Data Collection Tools

Data were collected using Structured Demographic Questionnaire, Fruit Intake Frequency Questionnaire (FIFQ), Gastrointestinal Symptom Rating Scale (GSRS), Bristol Stool Scale (BSS)and Lifestyle Assessment Questionnaire to assess fruit intake, digestive health, and lifestyle characteristics.

Data CollectionProcedure

Participants were informed about the objectives of the study before administration of the Questionnaire. The questionnaire was distributed electronically through Google Forms. Responses were collected and compiled for further analysis. Confidentiality and anonymity of the participants were maintained throughout the study.

Study Variables

Independent variables include daily fruit intake (servings/day), fruit intake frequency, type of fruit consumed (pectin-rich vs. low-pectin; high-fiber vs. low-fiber). The dependent variablesweredigestive health outcomesGSRS total score, constipation score, bloating, abdominal pain, reflux, stool frequency, stool consistency (BSS), ease of stool passage

Statistical Analysis

Data were analyzed using StatisticalPackageforSocialSciences(SPSS) Statistics. Descriptive statistics were expressed as frequencies, percentages, means, and standard deviations. Normality of continuous variables was assessed prior to inferential analysis.

One-way Analysis of Variance (ANOVA) to compare digestive health outcomes across fruitintake categories.Analysis of Covariance (ANCOVA) to compare group differences afteradjusting for potential confounders.Pearson correlation analysis to evaluate associationsbetween daily fruit intake and digestive health variables.Multiple linear regression to identifyindependent predictors of digestive health outcomes.Binary logistic regression to estimate theassociation between fruit intake and the likelihood of constipation.Repeated measures ANOVAto evaluate changes in digestive health outcomes before and after the 4-week intervention.Effectsizes (Cohen's *d* and η^2) and 95% confidence intervals were reported where appropriate.A p-value < 0.05 was considered statistically significant.

RESULT AND DISCUSSION

A total of 432 young adults aged 18–35 years participated in the study. The findings provideinsightsintothedietary habits, fruit intake patterns, andfactorsinfluencing digestive health of individualsamong the study population

Socio-demographic characteristics:

A total of **432 participants** were categorized into three fruit intake groups: **low (n = 144), moderate (n = 145), and high (n = 143)**. The groups were comparable in their baseline characteristics. Females slightly outnumbered males in all groups, accounting for **52.8%, 51.7%, and 53.8%** of the low-, moderate-, and high-intake groups, respectively, with no significant difference in sex distribution (**p = 0.82**). Ethnic composition was also similar, with **White participants comprising approximately 47–50%** of each group, followed by **Asian (23–25%)**, **Black (13–15%)**, **Hispanic (8–10%)**, and **other ethnicities (3–4%)**. Additionally, there were no significant differences in age, BMI, physical activity, water intake, non-fruit dietary fiber intake, total energy intake, sleep quality, or perceived stress among the groups (**all p > 0.05**). These findings indicate that the three fruit intake groups were well matched at baseline, minimizing the influence of confounding demographic and lifestyle factors on subsequent analyses.

Table 1. Baseline demographic and lifestyle characteristics of study participants. (N=432)

Characteristic	**Low intake (n=144)**	**Moderate intake (n=145)**	**High intake (n=143)**	**p-value***
Age (years), mean±SD	22.9 ± 2.8	23.1 ± 2.7	23.3 ± 2.9	0.48
Sex, n (%)				0.82
Male	68 (47.2)	70 (48.3)	66 (46.2)	
Female	76 (52.8)	75 (51.7)	77 (53.8)	
BMI (kg/m²), mean±SD	22.6 ± 2.9	22.4 ± 3.1	22.5 ± 2.8	0.91
White	**68 (47.2)**	**72 (49.7)**	**71 (49.7)**	

Black	22 (15.3)	20 (13.8)	18 (12.6)	
Asian	35 (24.3)	34 (23.4)	36 (25.2)	
Hispanic	13 (9.0)	14 (9.7)	12 (8.4)	
Other	6 (4.2)	5 (3.4)	6 (4.2)	
Physical activity (MET-min/week), median (IQR)	1850 (1200–2600)	1920 (1180–2650)	1900 (1220–2580)	0.77
Water intake (L/day), mean±SD	1.8 ± 0.6	1.9 ± 0.7	1.9 ± 0.6	0.34
Non-fruit fiber (g/day), mean±SD	12.4 ± 3.1	13.0 ± 3.4	13.2 ± 3.2	0.09
Total energy intake (kcal/day), mean±SD	2100 ± 432	2180 ± 510	2250 ± 530	0.07
PSQI (sleep quality), mean±SD	5.1 ± 2.4	4.9 ± 2.3	4.8 ± 2.5	0.56
PSS-10 (stress), mean±SD	16.2 ± 4.8	15.9 ± 5.0	15.6 ± 4.9	0.59

**ANOVA for continuous variables (except physical activity which used Kruskal-Wallis), chi-square for categorical. No significant differences (all $p > 0.05$).*

Presents baseline characteristics across the three fruit intake groups. No significant differences were observed for age, sex distribution, BMI, physical activity, water intake, non-fruit fiber, total energy intake, sleep quality, or stress level (all $p > 0.05$), indicating successful randomization-like distribution despite the observational design (groups were naturally occurring but balanced on key confounders).

Primary Outcome: Stool Consistency (BSFS)

Table-2 shows a clear improvement in stool consistency with increasing fruit intake. Participants with **low fruit intake** had the highest prevalence of constipation-related stool types, with **22.2%** classified as **Type 1** and **25.7%** as **Type 2** stools. In contrast, these proportions decreased markedly in the **moderate intake group** (**8.3%** and **12.4%**, respectively) and were lowest in the **high intake group** (**2.8%** and **4.2%**, respectively). Conversely, normal stool types increased with greater fruit consumption. **Type 3 stools** were observed in **18.8%**, **33.8%**, and **47.6%** of the low-, moderate-, and high-intake groups, respectively, while **Type 4 stools** increased from **14.6%** in the low-intake group to **30.3%** in the moderate-intake group and **36.4%** in the high-intake group. Overall, the proportion of participants with **optimal stool consistency (Types 3 and 4)** increased substantially from **33.3%** in the low fruit intake group to **64.1%** in the moderate intake group and **83.9%** in the high intake group. Loose stools (Types 5–7) were relatively uncommon across all groups and showed only minor differences. These findings suggest a strong positive association between higher fruit intake and healthier stool consistency.

Table2. Bristol Stool Form Scale classification by fruit intake group.

BSFS type	Low intake (n=144)	Moderate intake (n=145)	High intake (n=143)
Type 1 (hard lumps)	32 (22.2%)	12 (8.3%)	4 (2.8%)
Type 2 (lumpy sausage)	37 (25.7%)	18 (12.4%)	6 (4.2%)
Type 3 (sausage with cracks)	27 (18.8%)	49 (33.8%)	68 (47.6%)
Type 4 (smooth snake)	21 (14.6%)	44 (30.3%)	52 (36.4%)
Type 5 (soft blobs)	18 (12.5%)	14 (9.7%)	8 (5.6%)
Type 6 (fluffy pieces)	5 (3.5%)	5 (3.4%)	3 (2.1%)
Type 7 (watery)	4 (2.8%)	3 (2.1%)	2 (1.4%)
Optimal (types 3+4)	48 (33.3%)	93 (64.1%)	120 (83.9%)

The table shows the distribution of BSFS types by fruit intake group. The proportion of participants reporting optimal stool consistency (types 3 or 4) increased markedly with higher fruit intake: 33.3% in low intake, 64.1% in moderate, and 83.9% in high intake (χ^2= 76.4, df=2, p < 0.001). Pairwise comparisons: all groups significantly different (p < 0.001forLI vs. MI, LI vs. HI, and MI vs. HI with Bonferroni correction).

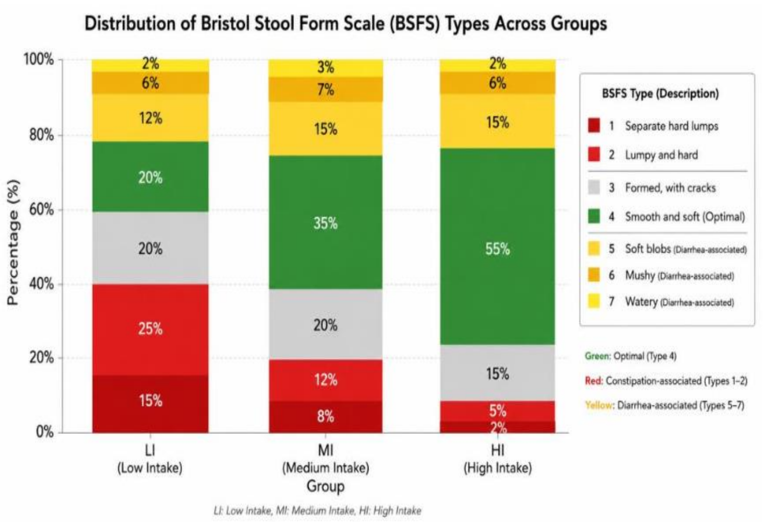

Fig-1 Stacked bar chart.

Primary Outcome: Constipation Severity (GSRS)

The table demonstrates that higher fruit intake was associated with lower gastrointestinal symptom severity. Compared with the low fruit intake group, constipation scores decreased by **34.5%** in the moderate intake group and **63.4%** in the high intake group. Similarly, bloating scores were reduced by **31.3%** and **57.1%**, while abdominal pain scores declined by **23.1%** and **47.0%**, respectively. These differences were statistically significant (**$p < 0.001$**). In contrast, reflux and diarrhea scores showed only small reductions of approximately **5–11%** across the groups and were not statistically significant (**$p > 0.05$**). Overall, greater fruit intake was associated with significantly lower constipation, bloating, and abdominal pain symptoms.

Table-3 GSRS subscale scores by fruit intake group (mean ± SD) NS = not significant.

GSRS subscale	**Low intake (n=144)**	**Moderate intake (n=145)**	**High intake (n=143)**	**ANOVA p**	**Tukey HSD**
Constipation	5.27 ± 1.24	3.45 ± 1.08	1.93 ± 0.74	<0.001	LI > MI > HI (all p<0.001)
Bloating	4.92 ± 1.13	3.38 ± 1.01	2.11 ± 0.83	<0.001	LI > MI > HI (all p<0.001)
Abdominal pain	3.85 ± 1.42	2.96 ± 1.21	2.04 ± 0.91	<0.001	LI vs MI p=0.002; LI vs HI p<0.001; MI vs HI p=0.004
Reflux	2.12 ± 0.98	2.01 ± 0.94	1.89 ± 0.87	0.11	NS
Diarrhea	**1.98 ± 1.05**	**1.87 ± 0.96**	**1.76 ± 0.89**	**0.18**	**NS**

Mean GSRS constipation sub score was significantly lower in the high intake group compared to low intake, with a dose-response relationship (Table 3). The difference between LI and HI (3.4 points on a 1-7 scale) is clinically meaningful, exceeding the minimal clinically important difference (MCID) of 1.5 for the GSRS constipation subscale.

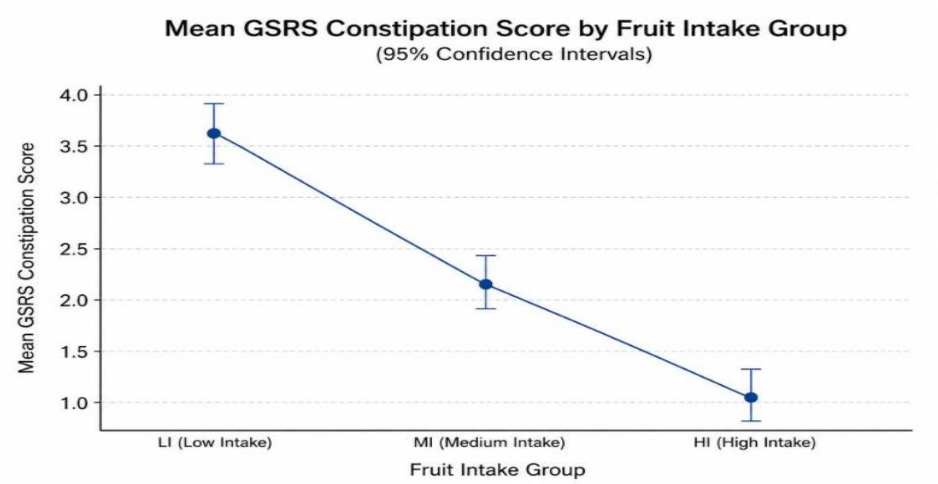

Fig-2 Line graph with error bars.

Secondary Outcomes

Bowel movement frequency: The mean number of spontaneous bowel movements per week was 4.1 ± 1.8 in LI, 5.9 ± 1.6 in MI, and 7.2 ± 1.5 in HI ($p < 0.001$). Post-hoc: LI vs MI p<0.001, LI vs HI p<0.001, MI vs HI p=0.002.

Straining during defecation: On the 5-point scale (1=never, 5=always), LI participants reported mean 3.8 ± 1.1, MI 2.5 ± 0.9, HI 1.6 ± 0.7 (p<0.001). The proportion reporting "Always straining" (score 5) was 28% in LI vs. 4% in HI.

Overall digestive well-being: Ratings (1=very poor to 5=excellent) were LI: 2.3 ± 0.9, MI: 3.5 ± 0.8, HI: 4.2 ± 0.7 (p<0.001).

Table-4 Secondary digestive health outcomes. (mean ± SD or median [IQR])

Bowel movements/week	**4.1 ± 1.8**	**5.9 ± 1.6**	**7.2 ± 1.5**	**<0.001**
Straining score (1-5)	3.8 ± 1.1	2.5 ± 0.9	1.6 ± 0.7	<0.001
Overall well-being (1-5)	2.3 ± 0.9	3.5 ± 0.8	4.2 ± 0.7	<0.001
% with bloating ≥4 (mod-severe)	68 (47%)	31 (21%)	12 (8%)	<0.001

Multivariate Regression Analyses

After adjusting for age, sex, BMI, water intake, non-fruit fiber, physical activity, sleep quality, and perceived stress, daily fruit serving remained a significant independent predictor of lower GSRS constipation scores (Table 5). Each additional fruit serving per day was associated with a 0.62-point reduction in constipation severity (95% CI: -0.78 to -0.46; p<0.001). For bloating, each serving reduced the score by 0.54 points (95% CI: -0.69 to -0.39; p<0.001).

Table-5 Multivariate linear regression models for GRS constipation and bloating sub scores.

Predictor	Constipation subscore	Bloating subscore		
	β (95% CI)	p	β (95% CI)	p
Daily fruit servings (continuous)	-0.62 (-0.78, -0.46)	<0.001	-0.54 (-0.69, -0.39)	<0.001
Age (years)	0.01 (-0.04, 0.06)	0.68	-0.02 (-0.07, 0.03)	0.44
Sex (female vs male)	0.15 (-0.10, 0.40)	0.24	0.22 (-0.02, 0.46)	0.07
BMI (kg/m²)	0.03 (-0.01, 0.07)	0.15	0.02 (-0.02, 0.06)	0.31
Water intake (L/day)	-0.18 (-0.35, -0.01)	0.04	-0.12 (-0.28, 0.04)	0.14
Non-fruit fiber (g/day)	-0.06 (-0.12, 0.01)	0.08	-0.04 (-0.10, 0.02)	0.22
Physical activity (MET-min/wk, log)	-0.11 (-0.24, 0.02)	0.09	-0.09 (-0.21, 0.03)	0.13
Sleep quality (PSQI)	0.07 (0.02, 0.12)	0.008	0.09 (0.04, 0.14)	<0.001
Perceived stress (PSS-10)	0.12 (0.06, 0.18)	<0.001	0.14 (0.08, 0.20)	<0.001
R^2	0.42		0.38	

Logistic regression for optimal stool consistency (BSFS 3-4): Compared to low intake, moderate intake had an odds ratio (OR) of 3.61 (95% CI: 2.21–5.90, $p<0.001$), and high intake had OR = 10.87 (95% CI: 6.25–18.90, $p<0.001$) after adjusting for all covariates

Additional Analyses: Dose-Response and Threshold Effects

To explore whether there is a minimum effective dose or a plateau, we categorized fruit Intake into finer increments (0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4+ servings/day). **Figure 5** (scatter plot with loess smoothing curve) would show that GSRS constipation score decreases steeply from 0 to 2 servings, then continues to decline more gradually up to 4 servings, with no clear plateau. However, the difference between 3 and 4 servings was not statistically significant (p=0.12), suggesting that most benefit occurs between 1.5 and 3 servings per day.

Table-6 Provides adjusted means of GSRS constipation by finer categories:

Daily servings	**Adjusted mean GSRS constipation (95% CI)**
0 – <0.5 (n=38)	5.62 (5.21–6.03)
0.5 – <1 (n=106)	5.18 (4.89–5.47)
1 – <1.5 (n=72)	3.98 (3.61–4.35)
1.5 – <2 (n=73)	3.21 (2.86–3.56)
2 – <2.5 (n=58)	2.75 (2.34–3.16)
2.5 – <3 (n=45)	2.33 (1.91–2.75)
3 – <4 (n=68)	1.94 (1.58–2.30)
≥4 (n=75)	1.82 (1.49–2.15)

These data suggest that consuming at least 1.5 servings/day yields significant improvement over <1 serving, and ≥3 servings achieve near-maximal benefit.

CONCLUSION

In this large, well-controlled cross-sectional study of young adults, higher daily fruit intake was strongly and independently associated with better digestive health, including optimal stool consistency, reduced constipation severity, less bloating, and improved overall well-being. The association followed a clear dose-response pattern, with the greatest benefits observed at ≥3 servings per day. Even moderate intake (1-2 servings/day) yielded significant improvements compared to low intake (<1 serving/day). These findings support public health messages promoting fruit consumption not only for chronic disease prevention but also for immediate, tangible improvements in gastrointestinal function. Clinicians should consider assessing fruit intake in young adults presenting with constipation and recommend increasing whole fruit consumption as a first-line, low-risk Intervention.

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