

# Positive Influence of Probiotics on the Mental Health Status of College Students: A Review

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## ABSTRACT

Evidence of a growing population with mental health issues is prevalent, notably in college students. Due to this, many researchers conducted a study on how to enhance the well-being of an individual. Literature explained the connection between the brain and gut axis and found out that consuming a significant amount of probiotics positively impacts an individual's mental state. Further study about this mechanism can imply more knowledge about the microbiome-gut-brain axis and aid in additional supplemental control associated with psychiatric health. This paper aims to determine the communication process between the gut and brain signaling and determine how prebiotics and probiotics or the so-called "psychobiotics" influence college students' psychological well-being. A total of 2,563 works of literature were gathered from credible sites, including PubMed and ScienceDirect, published between 2015 to present year. The literature studies expound on different mental health problems of college students and show the correlation of probiotic consumption to an individual's overall mental health impact. Throughout the extensive analysis of the literature gathered, this study suggests that probiotics can potentially increase the mental well-being of an individual. There is a number of evidence and data that support probiotics as a supplement that can help particularly in reducing signs of depression, anxiety, stress, and other mental health problems.

**Key words:** Anxiety, College, Gut-brain-axis, Mental Health, Probiotics, Stress.

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## INTRODUCTION

Mental Health is a part of one's overall general health, integral to one's functioning and development. It is not merely the absence of mental disorders. This encompasses one's emotional, psychological, and social well-being. It also dictates how an individual can handle stress and make life choices. There are multiple factors that can influence the level of mental health of a person, and these involve: (1) Social, (2) Psychological, and (3) Biological factors. That being said, poor mental health can be correlated with social change, stressful conditions, social exclusions, and unhealthy lifestyles.<sup>[1,2]</sup>

University life may be regarded as a developmental milestone in adolescents as they find themselves transitioning to young adults with greater responsibilities and challenges. A significant population of these university students opt to relocate closer to school, stay in dormitories where they adapt to daily routines and make decisions on their own. Some may even be forced to find balance between the academe and sustaining their own day to day finances. Students face new challenges as they embark on this new journey to adulthood, such as adjusting to the new academic lifestyle, expanding their network by meeting a myriad of personalities coming from different walks of life and learning new skills. These challenges can significantly affect the well-being and mental health of college students. To add to this, their situation is also compounded by an academic workload that they need to balance, manage and accomplish. This often translates to adapting a dietary habit composed of

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processed foods, easy to prepare meals rather than the fresh, healthy, home-cooked meals one is accustomed to when growing up. Sustenance is a necessity especially for college students, but it cannot be denied that processed, ready-to-eat meals may have disadvantages and can affect an individual's health, and this includes one's mental capacity.

The Gut-brain axis is two-way communication between the central nervous system and the gut. In fact, 90% of serotonin receptors are located within the gut or in what we called the enteric nervous system.<sup>[3]</sup> The homeostatic imbalance between the two could lead to illnesses and could greatly influence our emotional shifts. Since heavily processed food optimizes time for college students and is somehow considered budget-friendly, many choose to go for it, disregarding the fact that it possesses a risk regarding health.<sup>[4]</sup> The troubled brain can send signals to the gut and vice versa; intestinal or stomach distress can be a product of anxiety, depression, or stress. A healthy and balanced diet and avoiding processed food can contribute as anti-depressants.

Experts believed that microorganisms like *Lactobacillus* and *Bifidobacterium* play an important role in one's gut-brain axis as it: (1) produces neurotransmitters that can affect the appetite and mood of an individual, (2) reduces the inflammation in the body that can contribute to depression, and (3) affects cognitive function in response to stress.<sup>[5,6]</sup> Furthermore, this is supported by the study of the journal *Gastroenterology*, which found that women who consume yogurt with a mix of probiotics twice a day in four weeks were calmer when exposed to images of angry and frightened faces to others who did not consume yogurt with probiotics.<sup>[7]</sup>

Microorganisms living in your gut, such as probiotics, have the ability to maintain and restore normal microbial balance, which is the primary key in the treatment and prevention of specific mental health illnesses, including anxiety and depression. With enough supplementation and consumption of probiotic-containing foods such as dairy products and fermented foods, a healthy microbiota can be achieved to support higher brain function. It is also important to maintain gut-brain communication.<sup>[8]</sup> It plays an important part in proper gastrointestinal functions to aid with behavior, mood, psychological processes, and higher cognitive thinking.<sup>[9,10]</sup>

Collegiate life has the potential to affect the mental well-being of most students, often due to the changes in their environment and lifestyle. In line with this, the researchers would like to look at the positive effects of probiotics on the mental health conditions observed in

most college students, specifically anxiety, depression and stress.

## METHODOLOGY

### Literature Search

Related literature was retrieved on credible search engines such as PubMed and ScienceDirect using combinations of search terms including "Probiotics", "Lactobacillus", "Mental Health", "Stress", "Depression", "Anxiety", "College", "Young Adults", "University", "Gut-brain-axis", "United States", "Asia" and "Japan" without any restrictions in order to discover studies concentrating on the positive influence of probiotics in mental health.

### Eligibility Criteria

This study includes the effect of probiotics on mental health, mental health problems of college students, the causes of mental health problems on young adults/college students, gut health and its correlation with the brain, data that are published between 2015 to till date, and articles from credible sites like PubMed and ScienceDirect.

The exclusions in this study are non-college students, non-English studies, articles that are published before 2015, and articles from predatory sites.

Title and abstract screening were performed independently by the researchers to identify the articles of interest. The inclusion criteria established for this mini-review are the following: Credible databases with articles published in English between 2015-present has the following topics which include: (1) Effect of Probiotics on Mental Health problems, (2) Causes of mental health problems, (3) Stress, Depression and Anxiety on college students, (4) Published studies or clinical trials related to probiotics with college respondents, (5) Articles from credible sites such as: PubMed and Science Direct. While the exclusion criteria are (1) Review papers, (2) Studies not written in English, (3) With non-college respondents, (4) Years published before 2015, and (4) From predatory sites.

### Selection Strategy

The eligibility and discrepancies of the selected studies identified for inclusion were reviewed by the authors. The title and abstract of the studies were initially screened before full-text assessment of each potential eligible research article.

## Data Extraction

The authors extracted the study characteristics of the eligible articles such as: (1) the first author's name, (2) year of publication, (3) country of origin, (4) study design, (5) sample size, (6) respondents, (7) focused mental health problem, (8) study duration, (9) probiotic strain, and (10) the key findings of each study. Detailed data extractions of articles are outlined in Table 1.

## RESULTS

A total of 2,563 articles were retrieved during the initial search. Duplicated studies were identified using ZOTERO, an open-source management software used to organize materials and references for research. A total of 408 duplicated studies were removed, leaving 2,155 literature to be screened. The authors screened the title and abstract of each literature, leaving 60 articles left to be assessed for eligibility. After a full-text assessment of each potential eligible article, a total of 12 studies were gathered to be included in this review. The summary of the study selection process can be seen in Figure 1.

### Effect of Probiotics on Mental Health Problems

Significant mood, anxiety and cognitive symptoms are being experienced by patients who have depression. Nowadays, alteration of neurotransmitter activity in the brain using antidepressants improves these manifestations.<sup>[11]</sup>

Twelve studies aimed to examine the positive effects of probiotics in young adults under stressful conditions. Among these, two of the studies use multi-probiotic strain samples, and one from it treated with commercially available probiotics showing a significant influence of reducing stress, anxiety, and other negative effects.<sup>[12]</sup> Administration of probiotic *Lactobacillus gasseri* CP2305 shows improvement in alleviating anxiety, exercise-related fatigue, and depressive symptoms for 12 weeks of consumption as assessed using the Hospitality Anxiety and Depression Scale compared to the placebo group.<sup>[13]</sup> Similarly, daily intake of *L. gasseri* CP2305, led to present notable changes in stress-associated behavior and sleep-induced problems showing a significant decrease of ( $p < 0.001$ ) in the quality of sleep.<sup>[14]</sup>

Treatment with the *Lactobacillus casei* strain Shirota regulates the cortisol response at a moderate level (LcS vs placebo,  $p < 0.05$ ). This significant decrease in cortisol levels suggests being associated to improve the academic induced stress on college students.<sup>[15]</sup> Other studies have shown the benefits of *L. casei* strain Shirota in mediating the gut microbiota in relation to

reducing abdominal dysfunction. Depressive individuals tend to have a high percentage of Bacteroidaceae and a low amount of Lachnospiraceae. Daily intake of *L. casei* strain Shirota reduces the Bacteroidaceae improving discomfort in the gastrointestinal tract of the college students exposed to stressful conditions.<sup>[16]</sup> In addition, the administration of *L. casei* strain Shirota exhibits high beta brain waves, gamma brain waves, and delta brain waves. These results suggest that the higher amount of delta and theta brain waves in the probiotic group supports the evidence that it provides attention and relaxation to the individual under induced anxiety situations.<sup>[17]</sup> The supplementation of *Lactobacillus plantarum*, suggests having an effect on reducing the stress of a young adult.<sup>[18]</sup> This is due to the connection of decreased levels of cortisol ( $P < 0.05$ ) that is typically released to acute stressors and a significant increase in the level of lactobacilli ( $P < 0.001$ ) compared to the placebo group.

### The Effect of Probiotics on Changes of the Mood

Two studies conducted by different authors assessed the effect of probiotics on mood states. A study by Steenbergen, et al. (2015) examined the effects of multiple species of probiotics: *Bifidobacterium bifidum* W23, *Bifidobacterium lactis* W52, *Lactobacillus acidophilus* W37, *Lactobacillus brevis* W63, *L. casei* W56, *Lactobacillus salivarius* W24, and *Lactococcus lactis* (W19 and W58) on cognitive reactivity and mood as a marker for depression.<sup>[19]</sup> The study, which lasted 4 weeks, consisted of 40 young adults. The participants were equally and randomly divided into two; twenty participants with a mean age of 19.7 years and a mean BMI of 21.5 were placed under the placebo condition, the other 20 with the mean age of 20.2 years and a mean BMI of 22.6 were placed under the multi probiotics condition. The study used three types of questionnaires for the pre-intervention assessment and post-intervention assessment. First, LEIDS-r a 34 item questionnaire that assesses a person's cognitive distortions or vulnerability to depression based on 6 subscales: Aggression, hopelessness, acceptance, control/perfectionism, risk aversion, rumination. The scale for LEIDS-r are as follows: 0 ("not at all") - 4 ("very strongly"). Second, Beck Depression Inventory II (BDI-II) is a 21-item questionnaire assessing the existence and severity of current, over the past 2 weeks, depressive symptoms. The total score by adding all items for BDI-II falls into a scoring criterion (0-13: minimal depression, 14-19: mild depression, 20-28: moderate depression, and 29-63: severe depression). Third, the Beck Anxiety Inventory (BAI) is a 21-item questionnaire assessing

**Table 1: Clinical Trials involving the use of Probiotics on college or young adult respondents.**

No.	Reference	Study Area	Sample Size (N)	Respondents	Probiotic Strains	Study Duration	Findings
1.	Tran, et al., 2019	United States	86	College students from liberal arts	Commercially available probiotics	28 days	- Findings from the study suggested that as a whole, probiotics can significantly reduce panic anxiety and negative affect, which accounted for 35.41% of the anxiety variance. -A higher number of improvements was observed in the individual probiotic's conditions, indicating that CFU and species count may be the determining factors of the probiotics' efficacy.
2.	Sawada, et al., 2019	Japan	49	Japanese Student Athletes	<i>Lactobacillus gasseri</i> CP2305	12 weeks	-Daily intake of CP2305 relieved academic stress-associated symptoms in medical students
3.	Nishida, et al., 2017	Japan	32	2nd year Japanese Medical Students	<i>Lactobacillus gasseri</i> CP2305	5 weeks	-CP2305 is a potential para probiotic that regulates stress responses, and its beneficial effects may depend on specific cell component
4.	Takada, et al., 2016	Japan	172	Healthy Medical Students	<i>Lactobacillus casei</i> strain Shirota (LcS)	8 weeks	-Under stressful conditions, LcS prevents physical symptoms and excess secretion of cortisol. This is possibly through vagal afferent signaling to the brain and reduced stress reactivity in the Paraventricular nucleus in the hypothalamus.
5.	Kato-Kataoka et al., 2016	Japan	49	4th-grade medical students	<i>Lactobacillus casei</i> strain Shirota (LcS) - LcS YIT 9029	8 weeks	-The gut microbiota of patients with depression reportedly shows higher percentages of Bacteroidaceae and lower percentages of Lachnospiraceae at the family level compared with healthy controls. -The daily consumption of LcS significantly reduced the percentage of Bacteroidaceae at the family level -Systemic stress in relation to abdominal dysfunction decreased with LcS administration
6.	Adikari, et al., 2020	Malaysia	20	Young adult male football players in aged 18-21	<i>Lactobacillus casei</i> Shirota strain (LcS)	8 weeks	- Daily supplementation of <i>Lactobacillus casei</i> Shirota strain show higher delta and theta brain waves which provide evidence of relaxation and attention
7.	Venkataraman, et al., 2021	India	74	Students taking their undergraduate exam (ages 18-24)	Multi Probiotic strain ( <i>Bacillus coagulans</i> unique IS2, <i>Lactobacillus rhamnosus</i> UBLR58, <i>Bifidobacterium lactis</i> UBBLa70, <i>Lactobacillus plantarum</i> UBLP40 (each of 2 billion CFU); <i>Bifidobacterium breve</i> UBBR01, <i>Bifidobacterium infantis</i> UBBI01 (each of 1 billion CFU)	May and June 2019	-Multi-strain probiotic significantly reduced the level of stress assessed by using stress scales (PSS, DASS, and STAI) in students facing examination

Continued...

Table 1: Cont'd.

No.	Reference	Study Area	Sample Size (N)	Respondents	Probiotic Strains	Study Duration	Findings
8.	Steenbergen, et al., 2015	Netherlands	20	Healthy Young Students (Mean age 19.7 years)	<i>Bifidobacterium bifidum</i> W23, <i>Bifidobacterium lactis</i> W52, <i>Lactobacillus acidophilus</i> W37, <i>Lactobacillus brevis</i> W63, <i>Lactobacillus casei</i> W56, <i>Lactobacillus salivarius</i> W24, <i>Lactobacillus lactis</i> W19 and W58	4 weeks	-4 week multispecies probiotic intervention reduced self-reported cognitive reactivity to sad mood
9.	Murata, et al., 2018	Japan	177	First-Fourth year students, Department of Nutrition in Kyushu Women's University	<i>Lactobacillus paracasei</i> MCC1849	6 weeks	-The level of deterioration in the positive mood state caused by stress was less in the those who took MCC1849 than in the placebo group. -Regarding its effects on the common cold, no significant differences were noted in the incidence of the common cold among the groups. However, the incidence of infection in the placebo group was higher in the prespecified subgroup
10.	Andersson, et al., 2016	Sweden	41	University students with ages 18 to 30	<i>Lactobacillus plantarum</i> 299v	14 days	- A probiotic bacterium with ability to reduce symptoms of irritable bowel syndrome (IBS) prohibited increased levels of the stress marker cortisol during the examination period.
11.	Nishida, et al., 2017	Japan	69	6th year Japanese Medical Students	<i>Lactobacillus gasseri</i> CP2305	4 months	-Administration of <i>Lactobacillus gasseri</i> CP2305 for 4 weeks improved stress-associated behaviours in Healthy young adults and clinical symptoms in patients with irritable bowel syndrome.
12.	Möller, et al., 2017	United States	105	Students ages 18-23	<i>Bifidobacterium breve</i> , <i>Bifidobacterium longum</i> , <i>Bifidobacterium infantis</i> , <i>Lactobacillus acidophilus</i> , <i>Lactobacillus plantarum</i> , <i>Lactobacillus paracasei</i> , <i>Lactobacillus bulgaricus</i> , and <i>Streptococcus thermophilus</i> .	6 weeks	-It was hypothesized that a probiotic intervention administered for two weeks would reduce resting, stress, and recovery phase cardiovascular measures during an acute psychological stress task



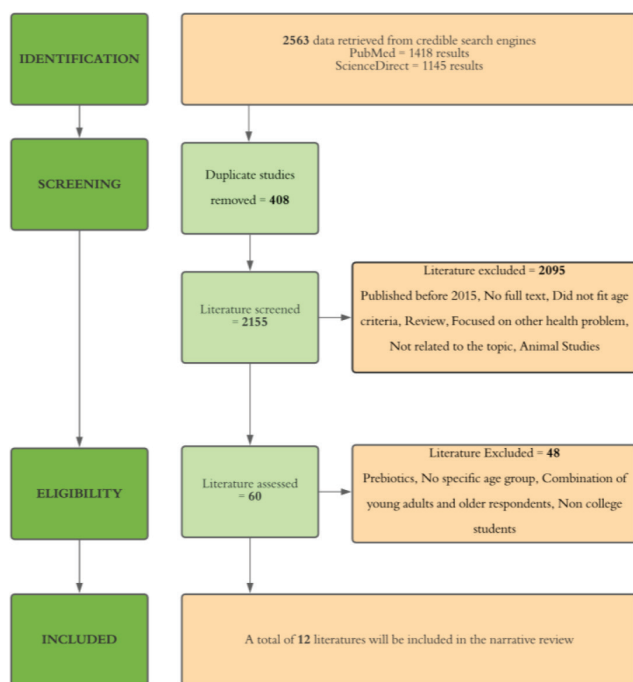


Figure 1: Schematic Diagram for Study Selection.

the existence and severity of anxiety symptoms. The sum for all items in BAI also falls into scoring criteria (0-9: normal anxiety; 10-18: mild-moderate; 19-29: moderate-severe and 30-63: severe anxiety). According to results, both placebo and probiotic groups have comparable scores in terms of depression and anxiety after the pre-and post-intervention. Bear in mind, no participant showed depression and anxiety on either occasion. Only minimal or mild scores were observed for both time points in BDI-II, the mean scores were 8.53, SD = 4.47, and 8.17, SD = 5.30, for the pre-and post-intervention assessment, respectively and BAI, the mean scores were 11.77, SD = 7.32, and 10.55, SD = 7.20, the pre-and post-intervention assessment, respectively. In LEIDS-r, the participants in the placebo group had no significant difference in the scores (total score:  $p = .63$ ,  $p(H_0|D) = .70$ ; aggression:  $p = .95$ ,  $p(H_0|D) = .80$ ; rumination:  $p = 1.0$ ,  $p(H_0|D) = .82$ ) while the participants in the multi-probiotic group had a significantly lower score in post-intervention compared to the pre-intervention. (total score:  $p < .001$ ,  $p(H_1|D) > .99$ ; aggression:  $p = .004$ ,  $p(H_1|D) > .99$ ; rumination:  $p < .001$ ,  $p(H_1|D) > .99$ ). The LEIDS-r result shows that a 4-week probiotic intake reduces cognitive reactivity, indicating a lower chance of depression and decreased aggressive and ruminative thinking.

Another study by Murata, *et al.* (2018) assessed the effect of probiotic supplementation on mood states. Randomized subjects were supplemented with powder-

containing  $1 \times 10^{10}$  heat-killed *L. paracasei* MCC1849 cells (10LP),  $3 \times 10^{10}$  heat-killed *L. paracasei* MCC1849 cells (30LP), or the placebo powder without probiotics for 12 weeks before being assessed.<sup>[20]</sup> The tool used for assessment is the profile of mood states 2 (POMS 2), a standard validated psychological test used to assess transient mood states. The T-scores of all mood states involving Total Mood Disturbance (TMD) scores and 7 mood clusters were assessed in POMS 2 short version: Anger-Hostility (AH), Confusion-Bewilderment (CB), Depression-Dejection (DD), Fatigue-Inertia (FI), Tension-Anxiety (TA), Vigour-Activity (VA), and Friendliness (F). Results show an increase in the scores of Vigour-Activity and Friendliness, which is a positive outcome. The subjects in the 10LP-intake group had a significantly higher score in the Friendliness criteria, compared to the placebo group ( $P < 0.05$ ), at 6 and 12 weeks. The T-score of the 30 LP-intake group also increased in the Friendliness criteria. Also, the scores of the 10LP-intake group significantly increased in Vigour-Activity at 6 weeks while those in the placebo group decreased at 6 and 12 weeks.

### Effect of Probiotics on Irritable Bowel Syndrome

Irritable bowel syndrome is a common gut disorder that affects 10% of the population, and individuals with irritable bowel syndrome are most likely to have a chance of experiencing mental health problems such as depression and anxiety due to the presence of “microbiota” that plays a role in communicating with the brain and can affect one’s mood and behavior.<sup>[21]</sup>

A study conducted by Andersson, *et al.* (2016), probiotic supplementation prohibited the increase of stress marker, cortisol, during the examination period of students from Lund University and provided a positive effect on the symptoms of Irritable Bowel Syndrome including bloating and pain.<sup>[22]</sup> All 41 individuals included in the study provided informed consent to participate in the study. The participants were divided into two: the experimental group ( $n=21$ ) were given a daily dose of colony-forming units of *L. plantarum* 299v in capsules and the placebo group which was given the same capsules but without the bacteria. The cortisol levels of both groups on the reference day (day 0) did not show a significant difference ( $P = 0.73$ ). The relative change between the median cortisol levels, compared to the reference day, suggested a significant difference ( $P < 0.05$ ) between the groups on day 10. On day 14, an abundance of *L. plantarum* in saliva significantly increased on the subjects supplemented with probiotics when compared to those given with the placebo product ( $P < 0.001$ ). Intake of *L. gasseri* CP2305 normalized

bowel habits under stressful conditions. Moreover, the daily dosage of *L. plantarum* improved bowel movements with normal stool frequency, alleviated IBS symptoms such as abdominal pains and bloating, and improved depression scores of 64% of participants within 6 weeks.

### Effect of Probiotics on the Quality of Sleep

A lack of sleep can influence an individual's digestive health, as the well-being of "gut microbiota" has been recognized as one of the factors that can impact one's sleep.<sup>[23]</sup> Therefore, sleep deprivation can decrease the level of leptin which has been found to be related to depressive behaviors in humans, which is why individuals who don't get enough sleep are more vulnerable to mood swings and depression.

Studies show that probiotics can help one's mental wellbeing as it improves the quality of sleep. A study by Nishida, et al. (2017) assessed if probiotic intake has a significant effect on the sleep quality of young adults, specifically on Japanese medical students.<sup>[24]</sup> They used the Pittsburgh Sleep Quality Index to assess the stress-related symptoms and sleep quality of their respondents. Results showed that administration of *L. gasseri* CP2305 improved the sleep quality of male students through assessment of PSQI scores, which changed from 5.44 to 4.04. From the seven components of the PSQI, 'latency' and 'duration' were improved by the administration of *L. gasseri* CP2305 with the values ( $P = 0.035$ ) and ( $P = 0.048$ ), respectively. On the other hand, female students did not show changes in their PSQI scores as there are differences in some aspects of sleep behavior on the two genders, such as quality, duration, chronotype, and the risk of progressing from sleep disorder to insomnia.<sup>[25,26]</sup>

### The Effect of Probiotics on Cardiovascular Function

One of the well-known effects of Probiotics is their ability to decrease the generation of reactive oxygen species that can result in decreased oxidative stress. However, few studies have been conducted when it comes to the effect of probiotics on cardiovascular measurement and its reaction to acute psychological stress. That being said, Möller, et al. (2017), administered a 14-day trial that evaluates the effect of Lactobacillus, Bifidobacterium and Streptococcus strains on cardiovascular measure and its reaction to acute psychological stress on healthy participants.<sup>[27]</sup>

The study showed that in contrast with the placebo group, the two-week probiotic supplementation did not affect the resting measures of cardiovascular function

and its response when under-recovery from stress or the psychological reaction to acute psychological stress. Furthermore, in contrast with their hypothesis, there were no significant changes identified between the probiotic and placebo effects on resting cardiovascular function and psychological reactions to acute psychological stress during the recovery phase.

### Effect of Probiotics on Common Cold

Most students entering Universities have experienced being sleep deprived and live a stressful life and this can make them prone to getting colds and upper respiratory infections.<sup>[28]</sup> Hence, Murata, et al. (2018) evaluated the effects of using probiotics supplementation on symptoms of common cold and mood states in healthy adults. The 177 respondents were given randomly a powder containing *L. paracasei* MCC1849 cell (LAC-Shield™) and a placebo powder for the placebo group. It showed that the *L. paracasei* MCC1849 administered has the potential to improve the resistance to common cold infections in vulnerable subjects and can maintain a prudent mood state, even if the individual is under mental stress.

Furthermore, the consumption of *L. paracasei* MCC1849 cell powder (LAC-Shield™) has been notable for its action to enhance immunity to suppress the onset symptoms of common cold and has been used in Japan by more than 250 food companies.<sup>[29]</sup>

## DISCUSSION

The positive influence of probiotics on the mental health of college students was examined using a narrative review. The researchers identified and assessed a variety of research articles that similarly tackles the topic of choice. Most of the study designs used by these research articles were double-blind, randomized, controlled, and placebo-controlled. During the full-text assessment of the research articles, a single noteworthy issue concerning the effect of probiotics on mental health was uncovered. However, numerous studies show that probiotics does have a positive influence in treating mental health problems such as stress, depression, and anxiety. Based on the data reviewed and gathered, we are one of the few who explored the positive influence of probiotics on the mental health of college students, as other studies focused on an older age group. After an in-depth and comprehensive examination of the research articles, the researchers gained a basic and general understanding of the concept of how probiotics work on human physiology, particularly its theoretical

benefits in the gastrointestinal system and how it can give a beneficial effect on mental health. The researchers hope that this paper would expand hypothesis formulation and investigation in regards to the other potential functions of probiotics.

This paper uses different Probiotics strains in identifying their effect on Mental Health. All twelve articles used humans as their respondents and eleven of them showed evidence that administration of Probiotics to individuals can improve their discomfort in the gastrointestinal tract, most especially when they are exposed to stressful conditions. However, one of them presented a different outcome. It appears that the effect of probiotics on mental health depends on the dosage and duration of consumption given to the respondents of each study, and this was supported by the experiment of Möller, *et al.* (2017). Based on their findings, the two-week probiotic supplementation did not affect the resting measures of cardiovascular function and its stress response, therefore, they suggested that future researchers must continue to examine the potential influence of different probiotic strains at different doses and combinations for longer durations.<sup>[27]</sup>

The strengths of this paper includes the classifications of different probiotics that positively influence the mental health of college students. This paper's several limitations must be taken into account in terms of interpreting the findings.

The researchers put the risk of bias across different studies, such as publication, performance, and reporting bias, along with potential conflicts of interest into consideration. Given that the researchers have limited time and resources because of limited access to some databases, a more accurate and precise way of reporting the study results would improve the quality of evidence. Evaluation on how probiotics' mechanism of action and how it positively impacts the mental health of an individual can further aid in the advancement of treating and preventing psychiatric disorders.

Overall, throughout the comprehensive investigation, this narrative review suggests that probiotics have a potentially positive effect that helps alleviate depression, anxiety, stress, and other mental health problems in young adults. Moreover, probiotics show a notable reaction to the general health of an individual, suggesting that it helps in improving discomfort in the gastrointestinal tract, enhancing the quality of sleep, and its significant effect on boosting immunity to restrain the development of common cold symptoms.

## CONCLUSION

In conclusion, some studies proved that probiotic intake has a significant positive effect on the gastrointestinal system and on the overall mental state of young adults. Further studies are needed to evaluate the factors contributing to the beneficial effect of each strain.

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## Author's Contributions

This study was proposed and conceptualized by Author D.A. Author R.G. led the group and set the cadence that resulted into the development and completion of the study. Authors G.L, N.D, and J.R. composed the abstract of the study. Authors R.G, D.A, T.A, J.B, and N.D. constructed the initial draft of the introduction. As for the Methodology, all authors contributed to the screening and assessment of each article included in the study, in addition to that all authors also contributed to the analysis and interpretation of the data gathered. Author G.L. provided the conclusion of the study. Author B.H. provided critical feedback, guidance, and assisted in developing the manuscript. All authors read and approved the final manuscript.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ABBREVIATIONS

**LcS:** Lactobacillus casei strain Shirota; **CFU:** Colony Forming Unit; **BMI:** Body Mass Index; **Leids-R:** Leiden Index of depression sensitivity revised; **BDI-II:** Beck Depression Inventory II; **BAI:** Beck Anxiety



Inventory; **POMS 2**: Profile of Mood states 2<sup>nd</sup> edition; **AH**: Anger hostility; **CB**: Confusion-Bewilderment; **DD**: Depression-Dejection; **FI**: Fatigue-Inertia; **TA**: Tension anxiety; **VA**: Vigor activity; **F**: Friendliness; **PSQI**: Pittsburgh Sleep Quality Index.

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