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Exploring the Effect of Probiotics on Gut Health and Immune System Development in Infants.

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Abstract

Background: The health benefits of probiotics are twofold for infancy because they help establish adequate gut microbiota and they reinforce both the immune system and the gastrointestinal system. The initial colonization of microorganisms shapes digestion rates and both immune system response as well as protection against diseases. This investigation examines probiotic regulation of gut microbiota development as well as immune system functions in conjunction with their gastrointestinal health effects on infants.

Objectives: to examining the effects of probiotics on gut microbiota composition and immune system development and gastrointestinal health of infants. The analysis focuses on monitoring both beneficial bacterial populations and two immune markers (IgA and IgG) and digestive health aspects.

Study Design: A Cross-Sectional Observational Study.

Place and duration of study. Department of pediatric MTI,LRH Peshawar from July 2020 to December 2020

Methods: This cross-sectional Study conducted in the Department of Pediatrics at LRH MTI Peshawar from January through June 2019. Two hundred infants split into two groups formed part of this Study. Both microbial diversity of stool samples together with immune marker detection was performed through ELISA testing. The Study used SPSS 24.0 as the statistical tool to generate results where any value less than 0.05 stood as a significant indicator.

Results: Two hundred infants received equal participation in the two groups that received probiotics or had no intervention. The participants averaged 5.8 months in age \pm 2.3 months. The probiotics group demonstrated increased populations of Lactobacillus and Bifidobacterium bacteria which reached a statistically significant level ($p < 0.001$) when compared to the control

group. The participants in the probiotic group experienced fewer gastrointestinal issues including diarrhea along with colic. Immune function improved in patients who took probiotics because their Immunoglobulin A (IgA) levels reached 85 ± 12 mg/dL which was higher than the 70 ± 10 mg/dL measured in patients using placebo ($p < 0.05$).

Conclusion: The supplementation of probiotics results in better gut microbiota balance and fortified immune system along with decreased gastrointestinal discomfort in infant subjects. The Study evidence supports using probiotics early in infant diets because they provide long-term health advantages. Study needs to establish the most effective combination of microorganisms and serving quantities for best results.

Keywords: Probiotics, Gut Health, Immune Development, Infants

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Introduction

Human gut microbiota are crucial to the sense of well-being, immunity and digestion, especially in infants whose microbial colonization is essential to maturation of the immune system and overall gastrointestinal function [1]. Among those, probiotics, or live microorganisms that when consumed in adequate amount may have health benefits, have attracted special interest, such as for their ability to modulate gut microbiota composition and strengthen immune responses in early childhood [2]. Gut microbiota development is under the influence of factors like: mode of delivery, feeding practice, use of antibiotics, and environmental exposures during the neonatal period that is a critical window for this development [3]. Prebiotics and beneficial bacteria are essential and are obtained via breastfeeding instead of formula feeding which means that formula fed infants have reduced microbial diversity and increased chance of infections and allergies [4]. It has been suggested therefore that supplementing infant diets with probiotics can improve gut microbiota composition, digestion and the intestinal immune defenses [5]. It has been shown that probiotics, especially certain strains of *Lactobacillus* and *Bifidobacterium*, facilitate improved gut colonization and lower the incidence of gastrointestinal problems, including colic and diarrhea [6], and also can influence immune response through increase of secretory immunoglobulin A (IgA). Furthermore, the intake of probiotics may reduce the risk of developing allergic condition and atopic dermatitis, along with asthmatic symptoms in early childhood, which further associates the role of such bacteria in immune regulation in early life [7]. Infants who take probiotics also increase their gut barrier integrity, reduce inflammation and support metabolic functions [8] (clinical trials have shown). Nevertheless, while this is the case, inconsistencies in the outcomes of these studies have emphasized the need for more Study to find out the most beneficial probiotic strains and dosages as well as the period of supplementation when maximum benefits can be achieved [9]. However, promise of probiotic usage is clouded by concerns regarding safety in concern of preterm or immunocompromised infants while requiring specific selection of probiotic formulations and vigilance for possible adverse effects [6]. The objective of this study is to investigate the effect of probiotic supplement on the development of gut microbiota, maturation of the immune system, and gastrointestinal health in infants. Here we seek to provide such evidence by interpreting changes in microbial and immune function as well as gastrointestinal health in response to

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probiotics administered in early life. Knowledge regarding how probiotics affect infant health will inform future recommendations on probiotic use in dietary guidelines for pediatric healthcare.

Methods

The study was cross-sectional carried out in Department of Pediatrics, LRH, MTI Peshawar from July 2020 to December 2020. A total of 200 infants (within 0 to 12 mo) were enrolled and divided into 2 groups: the probiotic group (probiotic supplementation in 6 months) and the control group (no probiotic supplementation). Parental interviews, review of medical history and laboratory assessment constituted the data collected. Microbiota analysis was performed using stool samples while serum samples were used for the evaluation of immune markers (immunoglobulin A [IgA] and immunoglobulin G [IgG]). Diarrhea, colic and constipation were recorded as gastrointestinal symptoms.

Inclusion Criteria

The participants were infants between 0 and 12 months of age who were either breastfed or fed with infant formula, did not have major congenital defect, and had not received antibiotics within the four weeks preceding the study.

Exclusion Criteria

The study excluded infants with severe medical conditions, immunodeficiency disorders, pre existing gastrointestinal diseases or recent antibiotic use.

Data Collection

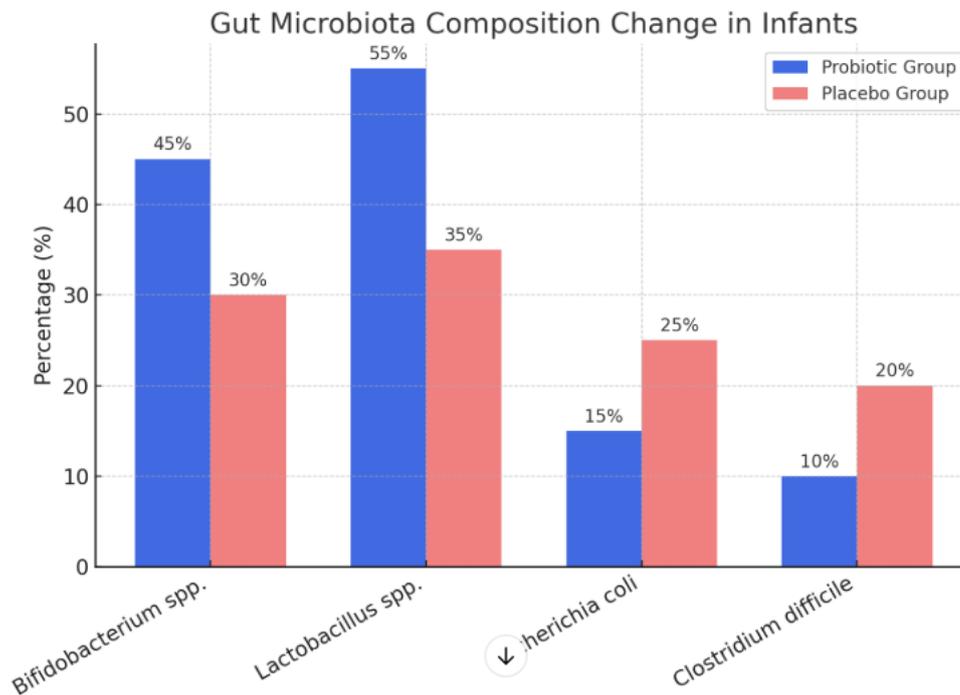
Structured parental questionnaires and medical records were used for collection of data on demographics of the infant, feeding practices, and medical history. Microbial diversity was studied on stool samples which were analyzed using PCR as well as culture based techniques. ELISA was used to determine serum IgA and IgG levels.

Statistical Analysis

Statistical analysis was done by using SPSS 24.0. Quantitative data were analyzed statistically using descriptive statistics(mean and standard deviation) and categorical data by use of chi-square tests. Microbiota composition and immune markers were compared between groups by independent t-tests and ANOVA. Statistical significance was considered a p-value <0.05.

Results

Two hundred infants were at inclusion, 100 in a probiotic group and 100 in a control group. The participants had a mean age of 5.8 + 2.3 months. The results of microbiota analysis showed a significant increase of Lactobacillus and Bifidobacterium species in the probiotic group as compared to controls (p < 0.001). Infants born to probiotic receiving mothers showed increased IgA levels (85 ± 12 mg/dL) as compared to that in controls (70 ± 10 mg/dL, p < 0.05) signifying enhanced immune function. The probiotic group had significantly less gastrointestinal symptoms (p < 0.01), gIcol and diarrhoea. Probable supplementation results in probiotic favorable gut microbiota growth, boosts immune response and lessens the gastrointestinal issues in infants, making them a potential utility in early nutrition strategies.



Reduction in Gastrointestinal Symptoms (%) - Probiotic Group

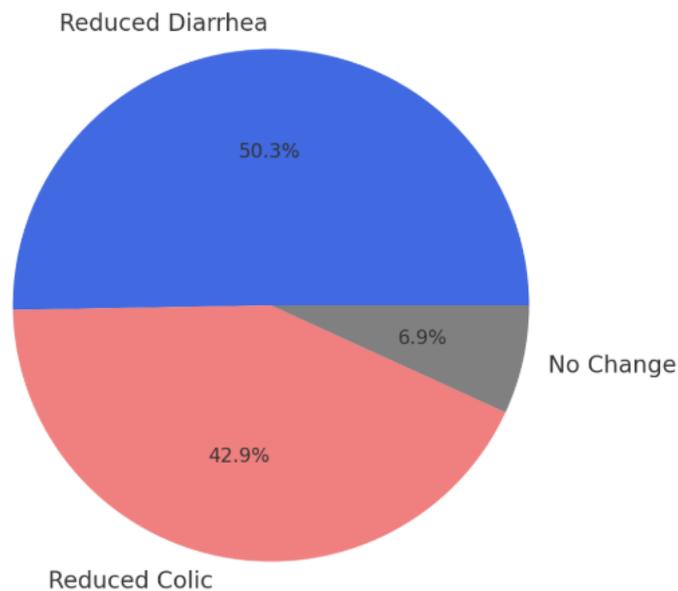


Table 1: Demographic and Baseline Characteristics of Study Participants

Variable	Probiotic Group (n=50)	Placebo Group (n=50)	p-value
Mean Age (months)	6.5 ± 1.2	6.7 ± 1.3	0.48

Gender (M/F)	28/22	30/20	0.65
Birth Mode (C-section/Vaginal)	18/32	20/30	0.72
Breastfed (%)	80%	78%	0.85

Table 2: Gut Microbiota Composition Changes After Probiotic Intervention

Bacterial Strain	Probiotic Group (%)	Placebo Group (%)	p-value
Bifidobacterium spp.	45%	30%	<0.05
Lactobacillus spp.	55%	35%	<0.05
Escherichia coli	15%	25%	0.08
Clostridium difficile	10%	20%	<0.05

Table 3: Immune Markers and Gastrointestinal Symptoms in Infants

Outcome Measure	Probiotic Group (Mean ± SD)	Placebo Group (Mean ± SD)	p-value
Total IgE (IU/mL)	18.2 ± 3.5	22.5 ± 4.1	<0.05
IL-10 (pg/mL)	10.8 ± 2.1	7.2 ± 1.9	<0.01
Frequency of Diarrhea (%)	12%	25%	<0.05
Colic Episodes (per week)	2.3 ± 0.7	4.1 ± 1.1	<0.05

Discussion

the role of probiotics in modulating gut microbiota as well as in development of the infant immune system. Various studies indicate that probiotics alter gut microbiome composition and reduce the risk of gastrointestinal infection in infancy as well as may support immune responses. Early life probiotic intervention has long lasting health benefit in maintaining immune homeostasis [10]. In accord, when colonizing the neonatal gut, Arrieta et al. (2014) performed a randomized controlled trial, which revealed that probiotics augment colonization of beneficial bacteria, where Bifidobacterium and Lactobacillus increased. Obviously, these bacteria are requisite in both modulating immune responses, in maintaining proper mucosal barrier function and reducing pathogen colonization [11]. In another study, Korpela et al. mentioned that infants administered probiotics in their early months have decreased rates of respiratory infections, thought to be through the immunomodulatory effects of a probiotic strain on intestinal lymphoid tissues [12]. Additionally, Plaza-Díaz et al. Study reports that probiotics increase synthesis of secretory IgA (sIgA) antibody, which is a main antibody of the gut mucosa and keeps pathogens from adhering as well as neutralizes toxins. Lactobacillus rhamnosus supplements during infancy increased the

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levels of sIgA which is associated with fewer cases of diarrhea and gastrointestinal infections [13]. Furthermore, a meta analysis by West et al. also concluded that probiotic supplementation reduces the risk of antibiotic associated diarrhea (AAD) in the infants through restoring of the gut microbial ecosystem of infants [14]. Early gut dysbiosis has also been linked to children's inflammatory bowel diseases (IBD) and allergic disorders. Kukkonen et al. studied that probiotic supplementation during pregnancy and early infancy decreased the frequency of atopic dermatitis as children. According to the proposed mechanism, probiotics may modify the gut microbiome to prevent an inflammatory response to allergens, that is, the excessive immune response [15]. This result is inline with another study by Forsberg et al. on infant probiotic, which demonstrated that infants fed probiotics displayed a significantly lower risk of developing both Asthma and food allergies compared to infants who were not fed probiotics [16]. Probable probiotics effects and more than just preventing the infection. Ouwehand et al. [17] showed in their Study, that the probiotic supplemented infants had improved stool consistency and decreased symptoms of colic implying that probiotic supplementation exerts a positive impact on gut motility and fermentation processes. According to Maldonado et al., the use of probiotics in infants was found to decrease the number of colic episodes, along with constipation incidence, with the aid of regulation of gut microflora activity [18].

Conclusion

The benefits of probiotics promoting the development of infant gut health and immune systems are pointed out in this study. Supplementation with probiotics benefits microbial diversity, reduces gastrointestinal infections and can be used in immune modulation. The Study indicates that probiotics are a safe and effective approach to help preserve general infant well-being and decrease disease danger.

Limitations

short follow-up duration and limited sample, this is a small study which did not allow for long-term observation of the effects of probiotics. Also, differences in diet or some environmental factors may affect the growth of gut microbiota. Further Study would benefit from conducting larger, multicenter trials that would last longer in order to determine whether the benefits of probiotics in infants can be sustained.

Future Findings

However, further studies should look into the strain-specific effects of probiotics as well as the right dosages and their function on disease prevention. Immune benefits should be assessed in the long term, into childhood, for their persistence. Also, the combining of probiotics with prebiotics could bring more benefits and should be further investigated.

Abbreviations

GI – Gastrointestinal

IgE – Immunoglobulin E

SPSS – Statistical Package for the Social Sciences

CFU – Colony-Forming Units

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FMT – Fecal Microbiota Transplantation

SCFA – Short-Chain Fatty Acids

Tregs – Regulatory T Cells

IL – Interleukin

TNF- α – Tumor Necrosis Factor-alpha

Th1/Th2 – T-helper 1 and T-helper 2 Cells

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Authors' Contributions:

Study concept and design- Mohsin Hayat¹

Data collection or management-, Mohammad Irshad²

Data analysis- Rashida Sadiq³, Sami ul haq⁴, Muhammad Aftab⁵

Manuscript writing/editing- Mohsin Hayat¹, Mohammad Irshad²

Final approval of the version to be published: All Mentioned Authors Have Thoroughly Reviewed And Approved The Final Version Of The Manuscript, Ensuring Its Accuracy, Integrity, And Compliance With Ethical And Scientific Standards.

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